FINAL SUMMARY REPORT

SEDIMENT MANAGEMENT UNIT 56/57 DEMONSTRATION PROJECT FOX RIVER, GREEN BAY, WISCONSIN

September 2001

Prepared For:
Fox River Group of Companies
and
Wisconsin Department of Natural Resources

• • •

Prepared By:
Montgomery Watson

Project No. 1242291/2082057.01470101

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MWH
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September 21, 2001

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Re: Final Summary Report
Fox River SMU 56/57 Demonstration Project, Green Bay, Wisconsin

Gentlemen:

Enclosed is the Final Summary Report for the Fox River SMU 56/57 Demonstration Project. The Report covers, among other things, the results of dredging that occurred in the Fall of 1999. An interactive CD-ROM containing the Report in PDF format will be sent to each of you next week.

Call me at 262-376-5080 if you have questions.

Sincerely,

MONTGOMERY WATSON HARZA

Richard H. Weber, P. E.
Principal Engineer

Enclosure: Final Summary Report (FRG – 25 copies; WDNR – 20 copies)

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EXECUTIVE SUMMARY

The Sediment Management Unit 56/57 Demonstration Project in Green Bay, Wisconsin was managed by the Wisconsin Department of Natural Resources (WDNR). The Fox River Group of Companies provided funding. Montgomery Watson was the engineer and general contractor. The purposes of the Project were to provide information for an assessment of the implementability, environmental effectiveness, and expense of large-scale sediment dredging and disposal from the lower Fox River, while removing PCB-containing sediments from the river ecosystem. Operational monitoring provided a substantial amount of implementation and cost information that the stakeholders can use for these assessments. Environmental monitoring was performed and reported upon by others.

Dredging was performed for a 15-week period between August 30 and December 15, 1999. A hydraulic dredge equipped with a 12-inch pump and a 9-foot wide horizontal auger cutterhead was used for most of the dredging work. An estimated 31,346 cubic yards of sediment and 1,441 pounds of PCBs were removed from the river. Water separated from the dredged solids was treated and discharged back to the river under a Project WPDES Permit. The treatment system included filtration and granular activated carbon; monitoring results indicated the carbon was necessary to comply with the PCB discharge limit of 1.2 ug/L. A total of 75,256,500 gallons of water were treated in the system with a normal operating capacity of 900 gallons per minute. The dredged solids were mixed with lime and dewatered in a series of plate and frame filter presses, having a total capacity of 800 cubic feet. The dewatered sediments were transported and disposed in a specially constructed cell at the Fort James Green Bay industrial landfill, under a permit modification from the WDNR. The work ended in December 1999 because of cold weather considerations, which delayed completion of demobilization and site restoration activities until June and July 2000. The Project costs totaled just under $12.4 million, inclusive of investigation, pre-design, procurement, permitting, and the value of in-kind services. The construction and monitoring portion was about $11.5 million, or $366 per cubic yard of sediment removed.

In three of four small areas where a clean-up dredging pass was performed, PCB concentrations in the surface sediments were less after dredging compared to before dredging. In the fourth location, the surface PCB concentrations were slightly elevated. In areas where a clean-up dredge pass was not able to be performed before ending the work, surface PCB concentrations were higher after dredging because sediment removal was not completed (i.e., dredging did not reach the target elevations).

This Project demonstrated, among other things, that PCB-containing sediments could be hydraulically dredged, mechanically dewatered, and disposed with large-scale equipment, but the production rates expected at the start of the Project were not achieved. This affected Project duration and cost, as well as the in-river sediment conditions left when the work ended.

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1.0 INTRODUCTION

1.1 PURPOSE

This report by Montgomery Watson summarizes information from the Demonstration Project performed at Sediment Management Unit 56/57 (SMU 56/57) in the Lower Fox River at Green Bay, Wisconsin. It was prepared for the purpose of disseminating information about the completed Project to the Fox River Group of Companies (FRG), the Wisconsin Department of Natural Resources (WDNR), and other stakeholders in the restoration efforts for the Lower Fox River.

1.2 BACKGROUND

In 1995, the WDNR and U.S. Environmental Protection Agency (EPA) performed an investigation in the approximately seven-mile reach of the Fox River between the DePere dam and the mouth of Green Bay. The investigation found a more-or-less continuous mass of soft sediments in the river bottom, whereas investigations above the DePere dam found the soft sediments were generally in discrete deposits. Approximately 100 sediment cores were collected below the dam, and depth intervals were analyzed for polychlorinated biphenyls (PCBs) and other constituents.

The results were used along with other data as input to a water and fish quality model by the WDNR to assist in making sediment and risk management decisions for the Lower Fox River. The model established a number of "sediment management units" in the river below the DePere dam. Cores within Sediment Management Units 56 and 57 were found to contain the highest known concentrations of PCBs in the river, up to 400 mg/kg in one core at a depth interval of 3 to 5 feet (ft). SMU 56/57 is located in the City of Green Bay on the west shore of the river, just upstream of a railroad trestle, in an area known as the Fort Howard turning basin (see Drawings A1 and A2).

It was earlier determined a source of PCBs in the river sediments was from wastewater discharges of paper mills during the manufacturing and recycling of carbonless copy paper. On January 31, 1997, the State of Wisconsin and Certain Companies Concerning the Fox River (i.e., the Fox River Group (FRG)) entered into an Agreement (State Agreement), which provided for, among other things, a sediment restoration project below the DePere dam. The FRG includes the following seven companies, who either have or had paper mills on the shores of the Fox River: Appleton Papers Inc., Fort James Corporation (now Georgia Pacific Corporation), P.H. Glatfelter Company, NCR Corporation, Riverside Paper Corporation, U.S. Paper Mills Corporation, and Wisconsin Tissue Mills Inc.

Using the 1995 investigation results, the WDNR isolated a focus area within SMU 56/57 as the location for the restoration Demonstration Project. According to the State Agreement, the Project was intended to remove contaminated sediment from SMU 56/57, and thereby to generate as much relevant information as reasonably possible for an assessment of implementability, environmental effectiveness, and expense of large scale sediment dredging and disposal from the Lower Fox River. Large scale, for purposes of this Project, was defined as potential removal of 8 to 11 million cubic yards (cy) of contaminated sediment from the river bottom over a period of 12 years.

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2.0 CONTRACTING ARRANGEMENTS AND PROJECT TIME LINE

The following summarizes the contracting arrangements on the SMU 56/57 Demonstration Project:

- Project Funding: The Fox River Group
- Project Manager: Wisconsin Department of Natural Resources
- Engineer and General Contractor: Montgomery Watson
  - Subconsultant: Harrington Engineering & Construction
  - Site Improvements Subcontractor: Terra Engineering & Construction
  - Dredging, Water Treatment, and Dewatering Subcontractor: Four Seasons Environmental
- Transportation and Disposal Services: Fort James Corporation
  - Transportation and Landfill Operations Subcontractor: Superior Special Services

Figure 1 provides a detailed Project time line. Work was initiated in September 1997 on the investigation and predesign phase of the Project, which ended in May 1998 with completion of the Basis of Design Report (BODR). The permitting and construction procurement phase extended between June 1998 and June 1999. The construction phase for sediment removal began in July 1999 with site improvements to an upland property near the dredge area, referred to as the former Shell Oil Company property, which is owned by Fort James. Site improvements were completed in late August 1999, as were mobilization of dredging, water treatment, and dewatering systems and personnel. Fort James' landfill construction was performed between middle June and late August 1999. Dredging began on August 30 and ended on December 15, 1999. Because of cold weather operating limitations, demobilization of some equipment and restoration of the Shell property was delayed. Demobilization activities were performed in June and July 2000.

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3.0 PERMITS AND APPROVALS

A number of permits and approvals were required from federal, state, and local authorities for Project implementation. Those that required public comment periods and/or information hearings are so noted.

- Environmental Assessment (EA), under authority of Chapter 150, Wis. Adm. Code and the Wisconsin Environmental Policy Act (WEPA). A two-week public comment period was held prior to approval.

- WDNR Dredging Permit, under authority of Chapter 30, Wis. Adm. Code. This permit also authorized placement of a silt curtain and temporary monitoring stations in the river in order to implement the Project.

- Army Corps of Engineers Dredging Permit, under authority of Nationwide General Permit 38, in accordance with 33CFR327.

- WDNR Wisconsin Pollution Discharge Elimination System (WPDES) Permit, under authority of Chapter 283, Stats. A public information hearing and comment period were held prior to approval. The water treatment subcontractor was required to submit a final design for the Project water treatment system under the seal of a Wisconsin registered professional engineer to the WDNR for review and approval before operation could begin.

- WDNR Plan of Operation Modification Approval, for landfill disposal of the dredged sediments, under authority of Chapter NR 500, Wis. Adm. Code. An EPA approval dated January 24, 1995 conditionally authorized WDNR to approve facilities for the disposal of sediments contaminated with PCBs. A public information hearing was held prior to approval.

- WDNR General Permit to Discharge Stormwater under the Wisconsin Pollution Discharge Elimination System, under authority of Chapters 147 and 283 Wis. Stats. and Chapter NR 216, Wis. Adm. Code. An Erosion Control and Stormwater Management Plan was required to be kept on site during construction activities, and a copy was also required to be submitted to the City of Green Bay.

- Fort James Access Agreement, signed by Fort James, the WDNR, and Montgomery Watson. It provided access to the former Shell Oil Company property and portions of the Fort James West Mill to implement and monitor the Project.

- City of Green Bay Zoning Approval, to Fort James as owner of the former Shell Oil Company property, for Project use. The zoning approval was for a temporary overlay of a planned commercial district. The request first received approval of the Plan Commission, followed by the full City Council, with opportunities in between for public comment.

- City of Green Bay Electric Permit, for extending temporary electrical power to the Shell property for operation of water treatment and dewatering systems.

- WDNR Waterway Marker Application and Permit, a permit obtained by the dredging subcontractor for temporary placement of buoys in the vicinity of the river work areas.

- Coast Guard Notification for Boaters Aid to Navigation, for informing recreational and commercial boat traffic of marker buoys, the silt curtain, and monitoring stations in the river.

- WDNR and FRG Approvals of an Operational Monitoring Quality Assurance Project Plan (OMQAPP). The OMQAPP described data collection and analyses to be performed by Montgomery Watson during the Project to monitor and control the construction operations. [A separate Environmental Monitoring QAPP was prepared by Blasland Bouck & Lee on behalf of the FRG, in cooperation with the WDNR and the Fox River Remediation Advisory Team (FRRAT). The FFRAT was established by the WDNR to advise the WDNR on scientifically valid approaches to monitor environmental effectiveness of dredging. FRRAT members include the U.S. Geological Survey (USGS), and the University of Wisconsin Water Chemistry Department, Water Resources Institute, and Sea Grant Institute. WDNR selected USGS to conduct water column sampling for the SMU 56/57 Demonstration Project. WDNR performed environmental air monitoring.]

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4.0 PROJECT COMPONENTS

4.1 INVESTIGATION AND PRE-DESIGN

The investigation and pre-design phase of the Project was performed between September 1997 and May 1998, when the Basis of Design Report (BODR) was submitted to the FRG and WDNR for review. The purpose of this work phase was to further characterize the river sediments and on-shore support areas to conceptually design a Demonstration Project to evaluate the efficacy of conducting full-scale remediation of the Lower Fox River. The Demonstration Project was to include dredging, on-shore dewatering and water treatment, and transportation and disposal at an approved Wisconsin solid waste landfill. Key information from the BODR is provided below.

4.1.1 SMU 56/57

The Project focus area within SMU 56/57 was selected by WDNR and FRG, and is adjacent to the Fort James West Mill in Green Bay (Drawing A2). A sheet pile water intake structure, located near the area, is used by Fort James for non-contact cooling water and manufacturing process water. This intake is vital to plant operations. Intake volumes vary, but can reach 50 million gallons per day (mgd) in summer months. North and south of the intake, the shoreline consists of earthen slopes protected by rip rap and aggregate debris extending about 30 to 40 ft into the river. The Fort James boat slip is located just north of the Project area, which is used during the navigation season for unloading boats (primarily coal) for the Mill's operations.

Thirty-two cores taken by WDNR and EPA in November 1997, and subsequently processed and tested by Montgomery Watson, indicated the sediments in the Project area are composed primarily of soft organic silt, overlying firmer native clay. PCB concentrations of the sediment ranged from non-detectable to 710 mg/kg. PCBs were predominantly identified as Aroclor 1242. The top 4 inches (in.) of sediment had PCB concentrations ranging from 1 to 99 mg/kg. Excluding the one core with 99 mg/kg, the PCB concentration of surface sediment ranged from 1 to 7.3 mg/kg, averaging 2.3 mg/kg. The highest PCB concentrations were located below a depth of 4 in. down to about 5 to 7 ft. The thickness of sediments containing at least 1 mg/kg PCBs ranged from 2 to 16 ft, and averaged about 10 ft.

Water depth in the Project area ranged from about 2 ft near the shoreline to 14 ft at the outer edge, except directly in front of the intake the water depth was about 19 ft. These depths were normalized to river elevation 579.2 Mean Sea Level (MSL, NGVD29). River velocity measured in the Project area one day in December 1997 ranged from 0 to 0.6 ft per second (fps). According to a USGS gaging station near the river mouth, flow velocity over the course of a year normally ranges from about +2.5 fps to –2.5 fps (i.e., flow reversal). Flow reversal can occur during strong and prolonged winds from the northeast.

4.1.2 Former Shell Oil Company Property

A 22-acre parcel known as the former Shell Oil Company property is owned by Fort James and located north of their Mill (Drawing A2). The property was identified for location of temporary on-shore water treatment and dewatering operations. The property was used as a bulk petroleum terminal from approximately 1940 to 1980, and included large aboveground storage tanks (ASTs), smaller underground storage tanks (USTs), loading racks and ancillary features. The Fort Howard Paper Company purchased the property in 1981. The petroleum fuel storage systems were subsequently removed form the parcel between 1981 and 1989. Earthen secondary containment dikes around the former ASTs were left intact in many locations. The property had not been used since demolition activities were finished.

4.1.3 Pre-Design of Project Elements

The conceptual pre-design from the BODR included the following Project elements: development of the Shell property, protection of the water intake, hydraulic dredging and dredge slurry transport to on-shore equalization basins, in-river sediment suspension control, treatment of dredge carriage water and discharge back to the river, sediment dewatering, and transportation and disposal at an off-site landfill. Some of the Project elements were designed only to the point of establishing performance requirements.

4.1.3.1 Intake Protection. If necessary depending on the final size of the dredge area, protection of the water intake would be accomplished by temporarily extending the intake upstream of the dredge area. Piping or a sheet pile channel were considered feasible options.

4.1.3.2 Dredging and Hydraulic Pipeline. To achieve the goal of large scale dredging established by the State Agreement, a dredging removal goal of 200 in-river cy/hour was established. This is based on one dredge taking 12 years to remove 11 million cy of sediment, operating 80% of the available time for eight months of each year. Hydraulic dredging was recommended given actual Project conditions (e.g., few known debris in river bottom away from the shore protection rip rap and debris; relatively shallow water depths and thickness of contaminated sediments; upland area available in close proximity for slurry discharge, dewatering, and water treatment). A dredge slurry pipeline would convey the dredged sediments to the Shell property. Alternative routes around the boat slip, or across the boat slip, were considered. As a condition of the Access Agreement, the Project could not deny access to the boat slip. The pipeline across the boat slip could either be submerged or be disconnected and reconnected each time a boat arrived. At the completion of production dredging, a clean-up pass would be performed to remove an additional 6 in. of sediment over the dredge area. The purpose of a clean-up pass is to remove contaminated sediments that potentially were re-suspended and subsequently re-settled in the dredge area, as well as potential undredged ridges between dredge tracks.

4.1.3.3 In-River Sediment Suspension Control. The Project dredge area would be isolated from the water intake and other areas outside the dredge area by installation of a temporary silt curtain system. Anchors in the river and on shore would hold the curtain in place. Buoys and lights would be placed for navigation in accordance with Coast Guard requirements. The silt curtain fabric could be permeable so that it would not have to withstand the pressure of full river currents, but the fabric openings would be small to limit migration of sediments potentially re-suspended by dredging activities.

4.1.3.4 Sediment Dewatering. Passive and mechanical dewatering options were considered in the BODR. Passive dewatering includes discharge of the all the dredge slurry into one or more large basins where the solids would settle and the water would be pumped off, treated, and discharged back to the river. The solids remaining in the basin(s) would passively dewater over a long period of time, expected to be two or more years based on bench scale testing. Then, the sediments would be solidified with the addition of a stabilizing agent (e.g., lime), if necessary, to transport and dispose the dewatered sediment as solid waste.

Mechanical dewatering would require much smaller basins because the dredged slurry would be processed each day to lower the water content (or increase the percent solids). Potential mechanical dewatering methods considered feasible included centrifuge, belt press, or filter press. Landfill disposal would occur within a few days of dredging for mechanical dewatering vs. years for passive dewatering. To shorten the time required to complete this Demonstration Project, the FRG and WDNR selected mechanical dewatering.

4.1.3.5 Water Treatment. Dredge carriage water (supernatant), sediment pore water removed during mechanical dewatering, and stormwater collected from the work pads would require treatment prior to discharge back to the Fox River in accordance with the Project-specific WPDES Permit. Discharge to a publicly owned treatment works (POTW) was considered, but this option was not available. Bench scale testing indicated that treatment could be accomplished by controlling suspended solids in the water, because PCBs are generally hydrophobic and generally attach themselves to solids instead of going into solution. Therefore, the solids removal treatment system was conceptually designed to include filtration followed by granular activated carbon.

4.1.3.6 Transportation and Disposal. After dewatering, the sediments would be loaded into dump trucks with sealed tailgates and tarps over the loads, and transported to an off-site landfill for disposal. This activity would be performed in accordance with state and federal requirements using licensed haulers and waste manifest forms. At the time of the BODR in May 1998, the WDNR was in the process of soliciting licensed solid waste landfills in Wisconsin for disposal of the dredged sediments. The EPA has granted the WDNR special authority to conditionally approve Wisconsin landfills to dispose PCB contaminated sediments at concentrations equal to or greater than the 50 mg/kg limit established by the Toxic Substances Control Act (TSCA).

4.2 PROCUREMENT AND PERMITTING

The procurement and permitting phase of the Project began in June 1998 and was completed in June 1999. Permits were listed in Section 3.0. The time line for each major permit or approval is summarized as follows:

Application	Submitted	Approved
Environmental Assessment	July 1998	September 2, 1998
WPDES Permit	July 7, 1998	September 15, 1998
WDNR Dredging Permit	July 7, 1998	September 9, 1998
Corps Dredging Permit	July 7, 1998	November 3, 1998

Written comments were taken by the WDNR on the EA and WPDES Permit, and a public information hearing was held prior to issuance of the WPDES Permit.

In July 1998 while the permit applications and EA were being reviewed, the FRG and WDNR notified Montgomery Watson of their desire to follow the design-build approach for Project implementation. A Request for Bid (RFB) for site improvements to the former Shell Oil Company property was developed, using "means and methods" specifications. This first RFB was issued to potential bidders on September 11, 1998.

A suitable state landfill to dispose of TSCA regulated sediments ($\geq$ 50 mg/kg PCBs) was unable to be secured by the WDNR in the summer and early fall of 1998. State officials had made a policy decision to dispose of the sediments from the SMU 56/57 Project within Wisconsin. Therefore, and because the Corps dredging permit was still not in hand, Project implementation was delayed until the 1999 construction season. In the interim, the search for a state TSCA disposal site continued and remaining permits and approvals were received.

Bids received on September 25, 1998 for site improvements to the Shell property were evaluated, and the work was scheduled for 1999. With concurrence from the FRG and WDNR, Montgomery Watson prepared three separate RFBs for dredging, water treatment, and dewatering to implement sediment removal. It was recognized that some environmental remediation contractors could have special expertise in a certain area, such as dredging, whereas others could have the qualifications and experience to perform all aspects of the work. Performance-based specifications were developed, to take advantage of contractor expertise and available equipment, and to provide flexibility. A summary of the Project specifications and work scope in each RFB is provided in the next section.

After pre-qualifying subcontractors, RFBs for dredging, water treatment, and sediment dewatering were issued in middle February 1999 to potential bidders. Pre-bid meetings were held at the site on February 23, 1999. At the time of the pre-bid meeting, Montgomery Watson collected sediment core samples in the targeted dredge area to provide bulk samples of sediment to interested bidders. Bids were received on March 26, 1999 as follows:

Construction Phase	Pre-Qualified Bidders	Bids Received
Dredging	15	9
Water Treatment	12	5
Dewatering	11	7

With concurrence from the FRG and WDNR, Four Seasons Environmental (FSE) was selected as the dredging, water treatment, and dewatering subcontractor, and Terra Engineering & Construction (Terra) was selected as the subcontractor for site improvements to the Shell property. Subcontract agreements were executed in June 1999.

The terms of the Fort James Access Agreement were agreed upon for use of the Shell property, and the document was signed by Fort James, the WDNR, and Montgomery Watson.

While the construction procurement activities were occurring, Fort James met with State officials regarding the possibility of them disposing of Project sediments in a specially constructed cell at their existing industrial landfill, located on the west side of Green Bay near the airport. Upon reaching agreement, Fort James submitted the Cell 12A Plan of Operation Modification to the WDNR on April 21, 1999. The WDNR and Fort James subsequently held a public information meeting in Green Bay in May, and the WDNR conditionally approved the Plan Modification on June 14, 1999.

4.3 CONSTRUCTION

4.3.1 Site Improvements

Site improvements to the former Shell property included:

- Clearing and grubbing of all trees and vegetation.
- Installation of erosion control measures, including a silt fence around the disturbed areas.
- Grading and construction of gravel access roads, parking areas, and work pads, and installation of a pre-cast concrete manhole for a water collection sump in the work pad to be used for water treatment and dewatering. This work pad measured about 130 by 240 ft, an area large enough to also include temporary stockpiling of dewatered sediments. A geotextile was placed over the subgrade for reinforcement before the work pad was constructed.
- Grading of two equalization basins where parts of containment dikes from former ASTs existed. Earth materials from other on-site berms were borrowed to construct the basins, having 2H:1V sideslopes. The basins each had plan dimensions of about 180 by 250 ft, and a depth of 4 to 6 ft. Thereafter, the basins

were lined with a 12-in. thick layer of imported landfill-quality clay, overlain by a 60-mil thick high density polyethylene (HDPE) liner.

- Installing temporary electrical lines and disconnects to the areas of the basins, and areas designated for water treatment, dewatering, and job trailers.

The water treatment and dewatering work pad was final graded and covered with bituminous asphalt. The asphalt was laid in two layers totaling about 4 to 8 in. in thickness for drainage to the sump. Site improvements began on July 12, 1998 and were completed by August 20, 1999. Drawing A3 is an aerial photograph of the former Shell property taken on September 29, 1999, and it shows the locations of the primary site improvements.

4.3.2 Dredging

The scope of work for dredging contained three primary items:

- Mobilization/ demobilization.
- Design, install, maintain, and remove the silt curtain.
- Operate the dredge systems and pipeline, and perform required dredge surveys and monitoring.

4.3.2.1 Silt Curtain. A silt curtain was installed around the entire dredge area. It was anchored on the upstream side between the dredge area and the water intake, and on the downstream side near the boat slip. A permeable turbidity barrier manufactured by Brockton Equipment/Spilldam, Inc. (Photo No. 1) was used. According to manufacturer specifications, the turbidity barrier had an 8-in. diameter closed cell foam flotation wrapped in orange 22-oz/sy, PVC-coated polyester fabric. The skirt below the flotation was made of black, woven polypropylene, monofilament geotextile fabric with a weight of 5.4 oz/sy, an equivalent opening size of 40-50 U.S. Standard Sieve (0.420-0.297 mm), and a percent open area of 15%. Skirt lengths were sufficient for the silt curtain to extend through the full water column to the top of the sediment.

Turbidity barrier panels, manufactured in 100-ft lengths, were joined in the field to approximately 1,700 lineal ft prior to deployment (i.e., 17 panels). The panels were joined using universal slide connectors and tied grommets at each end, as well as at the top using a 5/16-in. diameter cable and bottom using a 5/16-in. ballast chain sewn into the fabric. Deployment occurred in the last week of August 1999 and took several days. A combination of "Manta Ray" anchors and concrete weights were used to anchor the silt curtain once it was moved into position. Additional concrete anchors were placed during the Project because the silt curtain tended to move about with the wind and river currents. The silt curtain location is shown on Drawing A4, an aerial photograph of the dredge area taken on September 29, 1999. The top of the silt curtain contained battery powered lights in accordance with Coast Guard requirements.

In the early morning hours of September 24, 1999, Montgomery Watson discovered the silt curtain came apart at a panel joint, located approximately one-fourth of the curtain length from its southern shore anchor point. The curtain floated downstream against the piers of the railroad trestle. At daylight, the silt curtain was secured and plans were made for additional resources to get the curtain back into place. The next day, a crew was mobilized to re-position, re-connect, and re-anchor the silt curtain. No damage was done to the bridge. Several foam floats broke out of the top of the silt curtain and floated away; they were replaced with several air-filled buoys along the damaged sections. Also, another turbidity barrier panel was added at the location where it came apart.

4.3.2.2 Dredge Production Monitoring. A bathymetric survey was performed before starting dredging, but after silt curtain installation. After dredging began, additional bathymetric surveys were performed and the volume dredged between surveys was computed. A VersaFlow Doppler Flow Meter manufactured by TN Technologies was installed on the dredge pipeline near the east basin outfall to measure mass flow, flow rate, and total flow (Photo No.2).

4.3.2.3 Dredge System and Operation. Drawing A5 shows the targeted dredge area limits and dredge elevations, which were chosen to remove the greatest mass of PCBs within the least volume of sediment. Based on data and a GIS model reported in the May 1998 BODR, sediment below these elevations was expected to have PCB concentrations of <1 mg/kg. The dredge area was generally aligned with subunits of the grid system established by the GIS model. It was offset from the shoreline to avoid known rip rap and debris.

A hydraulic dredge with 12-in. pump and round cutterhead was mobilized to the site, and dredging began on August 30, 1999 in Subunits 12 and 23. After about one week of intermittent dredging, an IMS 4010 Versi Dredge (10-in. pump discharge) was mobilized to the site to try to increase solids content in the dredged slurry. It replaced the dredge initially mobilized. The IMS 4010 dredge began operation on September 5, 1999 with an in-line booster pump on shore near the north end of the dredge area to convey the slurry to the equalization basins. This dredge was replaced with an IMS 5012 Versi Dredge (12-in. pump discharge) and a larger booster pump on September 10, 1999. The IMS 5012 dredge had a six-cylinder diesel engine rated at 250 HP at 2,200 rpm. The dredge pump had a 9.75-in. diameter intake and a 19.25-in. diameter impeller. It was rated for a flow of 5,000 gpm at 85 ft total dynamic head and speed of 800 rpm. The booster pump was an 8-in. MXT Pekor Pump, with engine rated at 250 HP. The 8-in. diameter intake and discharge were converted with pipe fittings to a 12-in. diameter intake and discharge. It had a 25-in. diameter impeller. On September 22-23, 1999, a wider horizontal auger cutterhead (9-ft long by 22-in. diameter) was placed on the IMS 5012 dredge. This configuration was used for the remainder of the Project (Photo Nos. 3, 4, and 5).

Production dredging was performed in an east to west direction, perpendicular to the shoreline, beginning at the north end of the targeted dredge limits. The dredge moved from deeper water toward the shore using a travel cable windlass. The travel cable was stretched between a second cable anchored on shore and a third cable anchored east of the dredge area, forming an “I”-configuration. The river-side anchor cable was tied between a spud barge and the first dredge mobilized for the Project. Both the spud barge and the first dredge were temporarily anchored in the river with piles. For each dredge cut, the dredge moved along the travel cable, dredging a layer of sediment in each pass. According to operational records, the depth of cut for each pass ranged from 2 to 24 in., and averaged 12 in. A number of passes were required to progressively dredge down to the target elevation. When the cut at each dredge track was completed, grip hoists on the anchor cables were used to move the dredge side to side for the next cut.

According to the dredging subcontractor’s operational records, the dredge advanced at a rate of 0.5 to 4 ft/min while dredging, averaging 1.4 ft/min. The horizontal auger of the dredge cutterhead operated at a speed of 90 to 150 rpm, averaging 135 rpm. The “free turn” maximum speed was 187 rpm. The pressure on the cutterhead hydraulic motor was generally 2,200 to 2,800 psi, averaging 2,550 psi. The rated maximum pressure was 3,000 psi. The dredge pump typically operated at a rotation speed of 1,300 to 1,600 rpm, averaging 1,550 rpm.

On October 12, 1999, a bathymetric survey map of the partially completed dredge area indicated that the target elevation was not being reached, and that dredging activities were leaving behind ridges of undredged sediment between dredge cuts. With concurrence of the WDNR and FRG, production dredging was subsequently halted and the dredge was returned to previously dredged areas to remove the ridges and complete dredging to target elevations, progressing downstream from south to north. When the decision was made to re-dredge, the southern edge of the dredge area was approximated by a diagonal line extending between the midpoint of the west side of Subunit 18, to the northeast corner of Subunit 29 and part way into Subunit 39 (Drawings A5 and A10/A10-a).

Mass dredging ended on December 12, 1999 due to the onset of winter conditions. A clean-up pass was then performed in an approximately 30 ft by 30 ft area at the center of four dredge area subunits (Nos. 25, 26, 27, and 28 on Drawing A5). This was completed on December 15, 1999, and the dredge was demobilized.

The dredging crew generally consisted of three personnel: the dredge operator, a laborer stationed on-shore to operate the booster pump and assist with dredge repositioning, and another laborer stationed at the equalization basins to operate basin discharge valves and monitor the slurry flow meter.

4.3.2.4 Hydraulic Pipeline. The dredged slurry was conveyed through a pipeline that discharged to the equalization basins in a manner to protect the basin liner systems, with valves to direct the flow to either basin. The hydraulic pipeline was single-wall pipe inside the silt curtain, and it was double-wall (i.e., pipe inside a pipe) between the silt curtain and the basins for secondary containment in case of a leak in the inner carrier pipe.

The hydraulic pipeline consisted of 2,800 lineal ft of 12-in. diameter, butt-fused HDPE slurry pipe (SDR 17) inside 1,860 lineal ft of 16-in. diameter, butt-fused HDPE containment pipe (SDR 26) (Photo No. 6). A bolted flange coupling, located inside the silt curtain between the on-shore booster pump and boat slip, was used to disconnect the slurry pipe for boat access. The slurry pipeline had the outer containment pipe between this coupling and the southeast corner of the east equalization basin. The slurry pipeline was a single pipe between the coupling and the dredge. Before the pipe was uncoupled to allow boat passage, it was cleared of dredged slurry by pumping river water from the dredge to the basins. Upon re-coupling, river water was again pumped to check for leaks before dredging was re-initiated.

According to Fort James records, they received 15 boats during the dredging period. The time between arrival and departure at the boat slip ranged from 5 hours 15 minutes to 10 hours 45 minutes.

4.3.3 Water Treatment

The water treatment scope of work included:

- Final design of the water treatment system, in accordance with the WPDES Permit and performance specifications.
- Construct, mobilize, and install the water treatment system.
- Operate the water treatment system.
- Provide and use necessary coagulant/ flocculent.
- Provide and use necessary pH adjustment chemicals.
- Provide and change-out necessary granular activated carbon.
- Decontaminate and demobilize the water treatment system.

4.3.3.1 Design. The design of the water treatment system was submitted to the WDNR on July 28, 1999, who conditionally approved it on August 12, 1999. The design was based on meeting the following requirements:

Item	Specification
Flow:	Minimum capacity of 600 gpm.
Flow range:	Variable.
TSS @ discharge:	10 mg/L or less.
pH @ discharge:	Between 6 and 9 standard units.
Oil and grease @ discharge:	10 mg/L or less.
Influent turbidity:	Up to 1,200 NTUs.
Effluent turbidity:	Continuously monitored; daily maximum average of 5 NTUs.
WPDES Permit conditions:	Comply with pH, TSS, and oil & grease discharge limits.
Discharge:	10 fps minimum velocity according to the WPDES Permit's zone of initial dilution (ZID), with specific pipe size and orientation requirements.
Filtration:	Minimum use of granular activated carbon with a 10 minute empty bed contact time; other filtration as deemed necessary.
Normal operation:	24 hours per day, 7 days per week.
Project duration:	Estimated 6-8 weeks of successful facility operation.

A simplified process flow diagram of the water treatment system is shown on Drawing A6. The majority of flow to the water treatment system came from two sources, which were combined as influent to the treatment system: equalization basin supernatant (i.e., dredge carriage water after solids settling) and press filtrate (i.e., pore water squeezed from the sediment during mechanical dewatering). Another minor source of water was from the sump on the asphalt work pad, which was pumped into the press filtrate tank. The three treatment steps consisted of:

1. Primary Treatment: Chemical addition (i.e., polymer for TSS reduction and acid for pH reduction) followed by flocculation and equalization (Photo No. 7).

2. Secondary Treatment: Filtration through two dual media (sand/gravel) filter vessels, connected in parallel to allow periodic back-flushing of one filter vessel while still maintaining operation of the other filter vessel (Photo No. 8). Approximately 20,000 lb of filter media was placed into each vessel.

3. Tertiary Treatment: Polish through a granular activated carbon (GAC) vessel (Photo No. 8). Approximately 20,000 lb of GAC was loaded into the treatment vessel.

The first step of the water treatment system (chemical addition and flocculation) was located next to the settling basins. Tanks and equipment were set onto a plastic liner over a gravel pad, with a raised perimeter berm. The treatment vessels were located on the asphalt work pad. The layout is shown on Drawing A3, an aerial photograph of the Shell property on September 29, 1999. Most piping used in the water treatment system was 8-in. diameter, butt-fused HDPE (SDR 17). Approximately 900 lineal ft of piping connected the two treatment areas. The treatment system contained turbidity and pH monitors, and an effluent flow meter (flow rate and totalized gallons) on the discharge line. The approximately 1,800-lineal ft discharge line reduced to 4-in. diameter at a point near the shoreline, so the discharge velocity into the river would be at least 10 fps to comply with the WPDES Permit.

4.3.3.2 Operation. Installation and set-up of the treatment system were completed, and discharge of treated effluent to the river began on September 1, 1999. After several weeks of operation, it was decided to segregate the flows from the equalization basin supernatant and press filtrate and to process these flows through separate treatment systems. The purpose was to add capacity to the system, and to better manage turbidity and pH. Specifically, basin supernatant generally had higher TSS and turbidity than the press filtrate, whereas the pH of the filtrate was elevated due to the addition of lime during sediment dewatering. A water treatment design modification was submitted to the WDNR on September 21, 1999.

Two more dual media filter vessels and one more GAC vessel were installed near the equalization basins to treat basin supernatant (Drawing A7), whereas the original treatment system with slight modifications in piping was used to treat press filtrate (Drawing A8). Flocculation of the basin supernatant, after these modifications were made, occurred through the addition of polymer in the west basin, where the dredge slurry was discharged. At this point in time, use of the east basin for slurry discharge was halted. The water in the west basin was then pumped to the east basin for flocculation in a quiescent period before being pumped through the filters.

Effluent from both the supernatant and filtrate systems was combined into the discharge pipe. A pipe wye and valve were installed in the 8-in. diameter discharge pipe near the shoreline, and a new larger 5-in. diameter pipe was extended out into the river from this wye. This allowed discharge through either the reduced 4-in. or 5-in. diameter discharge pipe, depending on discharge flow rates, to maintain compliance with the minimum 10 fps discharge velocity. The separated water treatment systems began operation on October 17, 1999. The reported peak capacity of the revised water treatment system was 1,100 gpm, with a normal operating capacity of 900 gpm. Water treatment operations ended on December 18, 1999, three days after dredging ended.

A work crew of two per 12-hour shift generally operated the water treatment system. The treatment system operated 24 hours per day, 7 days per week, except for breakdowns and system modifications.

4.3.4 Dewatering

The dewatering work scope contained two primary items:

- Mobilization/ demobilization.
- Sediment dewatering (included slurry handling, water management, stockpiling, and loading) – payment made per dry ton of sediment processed.

The purpose of dewatering the sediment removed from SMU 56/57 was to allow effective handling and disposal of the sediment. The dewatering was to separate the solids and water from the dredge slurry. The dewatered sediment had to pass paint filter testing to be managed as solid waste.

Recessed chamber (also called plate and frame) filter presses were used for this Project. Four 100-cubic foot (cf) presses and one 200-cf press were initially mobilized, providing a total press capacity of 600 cf. The presses were manufactured by JWI. Loading of dewatered sediment into trucks for transportation to an off-site landfill began on September 9, 1999. To increase production, a second 200-cf press was mobilized and set-up on October 14, 1999, bringing the total press capacity to 800 cf. Dewatering operations ended on December 15, 1999, the same day dredging ended.

The layout of the presses and ancillary equipment is shown on Drawing A3, an aerial photograph taken of the Shell property on September 29, 1999. A simplified process flow diagram is shown on Drawing A9.

A small 6-in. hydraulic dredge with a horizontal auger cutterhead was placed in each basin (Photo No. 9) to remove the solids and convey them to the presses for dewatering. These dredges were basically smaller versions of the IMS 5012 river dredge. A cable and anchor system, like in the river, was used to position the dredge in each basin. Rubber-tired wheels were installed on each side of the horizontal auger on each dredge to maintain the cutterhead above the basin liner system during sediment removal.

Sediments from the basins were conveyed through approximately 1,200 lineal ft of 6-in. diameter HDPE pipe (SDR17) to a 20,000-gal mix tank located on the asphalt work pad (Photo No. 10). The dredge slurry from the basins passed through a 4 by 8 ft shaker screen with No. 4 sieve size before dropping into the mix tank. Gravel and/or debris from the screen fell onto the asphalt pad, where it was scooped up with a front-end loader and placed with the stockpiled dewatered sediment. Dry hydrated lime was fed into the tank and mixed with the dredge slurry. Lime was delivered to the site in bulk tank trucks and pneumatically fed to four lime storage silos (Photo No. 10). The dredge slurry with lime was pumped from the mix tank to a series of six 20,000-gal equalization/feed tanks (Photo No. 11), from which the slurry was pumped to the presses (Photo No. 12). When the second 200-cf press was added to the dewatering system, a seventh feed tank was also added.

Press cycle times varied greatly. The goal was to operate with press cycle times on the order of one hour. Water removed from the sediment was pumped to a 15,000-gal filtrate storage tank. When a press cycle was finished, plates were separated (Photo No. 13) and the filter cake (about 1-in. thick) dropped onto a conveyer under the plates. The conveyer dropped the filter cake into steel bins, where the front-end loader scooped it up (Photo No. 14) and placed it into the stockpile or directly into waiting trucks.

On September 28, 1999 after a weekly construction meeting, a flap of torn HDPE was observed in the bottom of the east equalization basin floating at the southeast corner, near the dredge slurry discharge point where the small dredge was pumping out solids for mechanical dewatering. Dredging to and from this basin was stopped immediately, and a plan for inspection and repair was developed.

The supernatant water and solids were removed from the east basin during the next two week period. Other cuts and tears in the HDPE liner were observed, determined to be caused by the steel shroud around the horizontal auger cutterhead of the small dredge. The wheels designed to keep the shroud off the bottom had apparently deflected, bending the axles connecting the wheels to the shroud, allowing the shroud to contact the liner.

A decision was made to cap weld an entire new bottom liner over the existing damaged liner. The 1-ft thick clay liner under the damaged HDPE liner was observed to be wet, but the clay liner integrity did not appear to be breached. The new HDPE liner was laid out in panels, which were fusion welded along seams. The entire top liner was then extrusion welded to the underlying liner around the top of the interior berm sideslopes. This work was completed and the east basin was put back into service on October 16, 1999.

While the east basin was out of service (2.5 weeks), only the west basin was used for discharging sediments dredged from the river. At this point in the Project, modifications had been completed to the water treatment system, adding the supernatant water treatment system, and using most of the original water treatment system for press filtrate. The modified water treatment system began operation on October 17, 1999. Accordingly, the east equalization basin was used for flocculation of supernatant water decanted from the west basin, and the east basin was never again used for discharge of dredged sediments from the river.

On November 26, 1999, while the supernatant level in the west basin was pumped down (water treatment had continued while the river dredge was temporarily down for repairs), two small breaches (about 2-in. and 12-in. long cuts, respectively) were noted in the HDPE liner. These breaches were about mid-height on the west basin sideslope liner, near the northeast corner where supernatant water was being pumped from the west basin to the east basin. The cause of these breaches was not determined, but one or both may have been caused by contact of the pump assembly on the liner when the water levels were pumped down. A decision was made to extrusion weld a piece of HDPE over each breach. This work was completed on November 30, 1999.

A typical work crew operating the dewatering system included six to seven personnel per 12-hour shift: the dredge operator in the basin, a laborer at the lime delivery system and mix tank, the loader operator, and three to four laborers operating the feed tanks and presses. The dewatering system generally operated at some capacity 24 hours per day, seven days per week, except for down time associated with system repairs and routine maintenance (e.g., maintenance and repairs of the pump on the mini-dredge, and maintenance and repairs of the press hydraulic pumps, air compressors, and conveyor belts). There was also one down time incident when a press operator's hand was injured between two adjacent filter plates while unloading filter cake.

The total work crew for dredging, water treatment, and dewatering was generally 11 to 12 laborers per 12-hour work shift. This number increased or decreased depending on site activities. An additional four operational personnel performed supervisory activities, health and safety oversight, and administrative activities.

4.3.5 Transportation and Disposal

Trucks were loaded using a front-end loader (Photo No. 15). It took only a few minutes to load each truck from the stockpile of dewatered sediment. Tri-axles and semi's were used. The trucks were weighed at the start of the day, on a temporary truck scale set up at the site, to determine a tare weight. After loading, the trucks were re-weighed (Photo No. 16). The scale was calibrated at the start of the Project. The tri-axle trucks carried approximately 15 to 18 wet tons of sediment, whereas the semi's carried approximately 20 to 23 wet tons. The truck boxes were covered with tarps (Photo No. 17). The loading area was carefully managed to keep the trucks from the stockpile and front-end loader work zone. For this reason, the trucks did not require washing before leaving the loading area.

A State of Wisconsin Uniform Hazardous Waste Manifest form was filled out for each truckload. A total of 1,240 loads of dewatered sediment were taken to the Fort James landfill (includes water treatment filter media and other Project wastes) between September 9, 1999 and January 17, 2000. On December 17, 1999, four additional truckloads (70 tons) of sediment were taken to the Brown County landfill in covered roll-off boxes under direction and control of the WDNR, to be used for pilot vitrification tests. It took about one hour for a truck to make a complete cycle between the site and the Fort James landfill. From two to five trucks were used each day hauling occurred, depending on the size of the stockpile to be removed. Hauling was permitted to occur seven days per week, but generally occurred only Monday through Friday because there was sufficient space on the asphalt pad to build up the stockpile over the weekends. During final demobilization in Summer 2000 (see Section 4.5), an additional 249 truck loads of solidified sediment and other Project wastes were disposed at the Fort James landfill.

4.4 OPERATIONAL MONITORING

Monitoring of the Project was performed to provide information for an assessment of implementability, environmental effectiveness, and expense of large-scale sediment dredging and disposal. Project monitoring was separated into two portions: Operational Monitoring and Environmental Monitoring. The monitoring and evaluation of the environmental effectiveness of the Demonstration Project were presented in the Environmental Monitoring Quality Assurance Project Plan (EMQAPP) by others, and are not covered in this report. Examples of environmental monitoring included water column sampling of the river before, during, and after dredging, as well as air monitoring. Although not a part of the EMQAPP, the FRG also performed caged fish monitoring for the Project.

An objective of the Operational Monitoring portion of the Project was to generate operational information on dredging, dewatering, water treatment, and disposal to supplement the environmental monitoring information that will be used by the stakeholders for their post-Project assessment. Further objectives of operational monitoring were to monitor subcontractor work activities, check compliance with Project permits, and measure subcontractor pay quantities.

An Operational Monitoring Quality Assurance Project Plan (OMQAPP) was prepared by Montgomery Watson for the SMU 56/57 Demonstration Project. In August 1999, it was approved by members of the FRG, WDNR, and EnChem, the analytical laboratory retained by Montgomery Watson for most of the testing required by the OMQAPP. The OMQAPP describes data collection and analyses that were performed during the Project to monitor construction operations, and to ensure that Project operations did not impact Fort James operations.

Components of the operational monitoring program were:

1. Collect geotechnical and construction quality control data for earthen and geosynthetic materials in the Shell property equalization basins to ensure the integrity of the basins.

2. Collect river water turbidity data during installation and removal of the silt curtain to determine whether sediment resuspension occurs and to what levels.

3. Collect real-time turbidity data within and outside of the silt curtain during dredging to monitor the performance of the silt curtain, and to optimize dredging operational parameters to minimize sediment resuspension.

4. Conduct sediment surface surveys before and after sediment removal and monitor dredge slurry flow rates to determine and optimize the sediment removal rate and efficiency.

5. Perform optical surveys of the Fort James shoreline adjacent to the dredge area, and bathymetric surveys of shoreline transects into the dredge area, to monitor slope stability during and after dredging.

6. Obtain processed sediment PCB, mercury, percent solids, water content, strength, and paint filter test data after mechanical dewatering to assess the performance of dewatering/solidification systems and permit operational adjustments to minimize the cost of sediment disposal.

7. Collect water discharge concentration and flow rate data as required by the WPDES Permit.

8. Obtain water quality data at various points within the water treatment system to allow effectiveness evaluation of specific treatment system components and optimization of operational parameters and system configuration.

9. Collect additional analytical data of Project consumables (i.e., water treatment filter media) upon completion, as required for proper disposal.

Before dredging began, Montgomery Watson agreed to assist with a component of the environmental monitoring program, because it involved sampling activities at the equalization basins and Montgomery Watson personnel were already going to be in this area on a daily basis. This component was sampling the dredge slurry from the pipeline before discharge to the basins. As the dredging work was nearing the end, the FRG and WDNR also contracted Montgomery Watson to collect post-dredge sediment cores and submit them to EnChem for analytical testing. At the same time, Montgomery Watson also had a post-dredge bathymetric survey performed, and this information was compared to the pre-dredge survey performed by the Corps of Engineers for the WDNR.

Details of the monitoring program are available in the OMQAPP, but a summary is provided hereafter.

4.4.1 Equalization Basin Liner Testing

The operational monitoring program included collection of geotechnical and construction quality control data of earthen and synthetic materials during construction of the equalization basins on the former Shell Oil Company property.

Compaction tests (ASTM D698, D2922, and D3017) were performed with a nuclear density meter on the general fill materials used to construct the berms, and on the clay soils used to construct the 12-in. thick soil liner. General fill was obtained on-site, whereas clay soils were trucked from an off-site borrow source. Samples of the compacted clay were collected and tested for Atterberg limits (ASTM D4318), grain size - sieve and hydrometer (ASTM D422), and hydraulic conductivity (ASTM D5084) to check compliance with the specifications in the OMQAPP. Surveying the top and bottom of the liner on a grid system also checked the clay liner thickness.

Quality control and quality assurance testing were performed during installation of the 60-mil HDPE liner above the clay, in accordance with the Project specifications in the

OMQAPP. Both non-destructive tests (ASTM D5641 and D5820) and destructive tests (ASTM D4437) were performed to check seam integrity.

4.4.2 Turbidity Monitoring During Silt Curtain Installation

Turbidity readings were taken before and during installation of the silt curtain around the dredge area, generally at six-tenths the water depth (0.6D) of each location. Readings were taken from a boat using a Model 6820, self-cleaning turbidity sensor and Model 610 display and logger unit; both are manufactured by YSI Incorporated. The turbidity sensor has a reported range of 0 to 1,000 NTUs, a resolution of 0.1 NTUs, and accuracy of ± 5% of the reading or 2 NTUs, whichever is greater. Coordinate locations (Wisconsin State Plane, North American Datum 1927 (NAD27)) of the turbidity readings were determined using a Trimble, Model ProXR differential global positioning system (GPS). Reported accuracy of the GPS is ± 1 m. River velocity was also generally recorded when turbidity measurements were taken. A Marsh-McBirney, Flo-Mate Model 2000 portable flow meter was used. It has a velocity range up to 20 fps, resolution of 0.01 fps, and accuracy of ± 2% of the reading. These instruments were factory calibrated at the start of the Project.

4.4.3 Real-Time Turbidity Monitoring During Dredging

After silt curtain installation, real-time turbidity monitoring was conducted at six locations:

- Upstream of the dredge area outside the silt curtain (USO).
- Upstream of the dredge area inside the silt curtain (USI).
- Sidestream of the dredge area outside the silt curtain (SSO).
- Downstream of the dredge area outside the silt curtain (DSO).
- Downstream of the dredge area inside the silt curtain (DSI).
- Fort James water intake (FJI).

Monitoring locations are shown on Drawings A4 and A5. A YSI 6820 self-cleaning turbidity sensor was installed at each location, suspended inside a perforated PVC pipe at approximately 0.5 to 0.6 the river depth. The turbidity sensors were connected to a YSI 6200 data collection platform. The two upstream turbidity sensors shared a common data collection platform installed at USO via cabling on floats to USI. The two downstream sensors were installed in the same fashion. SSO and FJI had their own data collection platforms. Each data collection platform included a solar panel and battery, two-way radio transceiver, and directional antenna. Data collected in the river was transmitted by radio to an antenna and YSI 6250 base station unit at Montgomery Watson's job trailer at the Shell property. The base station transmitted the data to a personal computer, where it was stored on the hard drive and displayed in real time using YSI's EcoWatch software.

Each turbidity sensor also recorded water temperature. At FJI, an electronic transducer was also installed on the turbidity sensor to record water depth, which was then converted to river elevation by adding the recorded depth to the surveyed elevation of the transducer. (Note: A benchmark elevation error was discovered late in the Project, which required the addition of 0.2 ft to correct the recorded river elevations at FJI. The corrected data are reported herein.)

At SSO, a Son-Tek Argonaut-SL side looking acoustic doppler current meter was also installed to record river velocity and direction. The velocity meter was positioned to record flow vectors parallel (i.e., downstream (positive) and upstream (negative)) and perpendicular (i.e., toward shore opposite the dredge area (positive) and toward shore adjacent to the dredge area (negative)) to normal river flow. The reported range of the velocity meter is $\pm$ 6 mps (about 20 fps), with a resolution of 0.1 mps (about 0.3 fps) and accuracy of $\pm$ 1 % of the measured velocity. The FJI transducer and SSO velocity meter were factory calibrated at the start of the Project.

The real-time turbidity monitors in the river (USO, USI, SSO, DSO, DSI) were initially installed on custom made floats approximately 4 ft by 5 ft in size (Photo No. 18), anchored at each corner with a rope tied to a concrete block. However, instability problems with the floats in rough water led Montgomery Watson to replace the floats with 6-in. or 8-in. diameter steel pipe piling (Photo No. 19), which were installed for us by McMullen & Pitz on October 5, 1999. A battery-powered, flashing amber beacon was installed at each river monitoring station. The turbidity monitor and transducer at FJI were installed on a wooden pole next to the water intake.

A YSI Model 6213 meteorological station was also installed on shore near the Fort James boat slip (Drawing A5). It contained its own data collection platform, solar panel, battery, radio, and antenna, which transmitted data to the base station at the job trailer for real-time display. Data collected included temperature, wind speed, wind direction, relative humidity, and rainfall. The met station was factory calibrated at the start of the Project.

The real-time turbidity sensors and met station were programmed to record measurements at 15-minute intervals, 24 hours per day. Monitoring continued through the dredging period and beyond, until the instrumentation was dismantled, generally in late December 1999. Montgomery Watson sent to members of Fort James, the FRG, and WDNR daily files of the recorded data via electronic mail, which could be viewed on their respective personal computers using YSI's EcoWatch software. Periodic data gaps occurred, during replacement of the floating platforms with the fixed piling, and during mechanical problems with the instrumentation. Repeated problems were had with the river velocity meter, apparently as a result of radio signal interference with the turbidity sensor, which were not resolved until near the end of dredging.

The 6820 turbidity sensors were factory calibrated. Calibration was checked in the field at the time of deployment using the hand-held display unit and 0 NTU (de-ionized water) and 100 NTU standard solutions provided by YSI. Calibration of the spare 6820 turbidity sensor, used for manual turbidity readings in the river and for water treatment sampling, was checked daily with the 0 and 100 NTU standard solutions. The calibration was adjusted, as necessary, to maintain zero scale and readings within ± 5 NTU using the 100 NTU standard solution (i.e., ± 5%). The hand-held display unit and spare turbidity sensor were used for weekly checks of the real-time turbidity sensors. First a reading was taken with the spare unit next to the real-time unit. Then the real-time unit was disconnected from the data collection platform and subsequently connected to the hand-held unit. The readings were compared. If they were within ± 5%, no action was necessary. If they were different by more than 5%, the real-time unit was removed from the river, and the sensor was cleaned, replaced, and checked again. Cleaning of the sensor was seldom necessary due to its self-cleaning mechanism of the optics.

4.4.4 Dredge Production Monitoring

A doppler flow meter was installed on the dredge slurry pipeline to measure slurry density, flow rate, and total flow. However, the dredging subcontractor experienced numerous problems maintaining and monitoring this meter throughout the Project. Examples of the problems included occasional loss of electric power to the instrument, and periodic and random stoppage of the flow meter operation for unknown reasons. This caused gaps in data acquisition, which led the subcontractor to often estimate results in his daily reports. Further, reported daily values for slurry density (in dry tons) consistently overstated the dredged mass removed, based on comparison to in-river dredge surveys and percent solids test results on slurry samples. For these reasons, Montgomery Watson considers the data to be unreliable and a discussion of the results is not included herein.

A pre-dredge survey was performed on August 14, 1999. Dredging began on August 30, 1999. An echo-sounder in a boat, which traveled along transect lines parallel to the shoreline, was used to collect bathymetric data. Coordinate positions were determined using a total station on shore and a prism in the boat. Thirteen subsequent production surveys were performed: on September 16 and 28; October 4, 7, 15, 22, and 29; November 4, 11, 22, and 30; and December 3, and 12, 1999. About one month before dredging ended, the positioning method was changed by integrating a GPS in the boat with the echo-sounder. A post-dredge survey was performed on January 8, 2000, but a small area at the northwest corner of the dredging limit could not be completed due to the presence of ice.

4.4.5 Shoreline Stability Monitoring

Montgomery Watson established a target dredge area that was about 20 ft beyond the edge of measured shoreline debris (Drawing A5), which was approximately 50 ft from the water's edge depending on river level. As requested by Fort James, Montgomery Watson monitored the shoreline adjacent to the dredge area to check for potential slope instability caused by dredging. The monitoring included optical surveys along the shoreline and bathymetric surveys perpendicular to the shoreline. These surveys were performed between dredging events, generally daily, at 50-ft stations established by a surveyor for Montgomery Watson before dredging started.

Optical surveys were performed by sighting with a transit between control points along a baseline of wooden hubs set at 50-ft stationing. Horizontal offsets from the sight line, if any, were measured and recorded. The elevations of the wood hubs were also surveyed with the transit or a level, and compared to elevations prior to dredging. No lateral movement was detected over the 3.5-month dredging period, and only slight vertical movement (within survey precision) was measured.

The bathymetric surveys were performed at transect lines at the 50-ft shoreline stationing. The top of sediment was sounded, and the elevation of the sediment was determined by subtracting the river elevation (using a staff gage installed at the Fort James water intake) from the water depth. The bathymetric surveys were generally performed by wading from shore, but a boat was also used. Measurements were taken at 10-ft intervals, beginning at a stake on shore and extending approximately 50-ft out into the river. Recorded elevations were compared to pre-dredge elevations along the transects. No appreciable differences were observed, and the bathymetric surveys were stopped on October 1, 1999 with approval of Fort James. Cessation was approved because the optical monitoring to this point in time was showing no shoreline instability, and because the bathymetric surveys were labor intensive and time consuming to complete.

4.4.6 Dewatered Sediment Monitoring

The dewatered sediments had to pass the paint filter (free liquids) test in order to be classified as non-liquid wastes for landfill disposal under Wisconsin solid waste regulations. A target of 58% solids and an unconfined compressive strength of 0.4 tsf were also established so that the dewatered sediments would have adequate physical characteristics for handling and disposal. In addition to these physical characteristics, the FRG, WDNR, and Fort James were interested in knowing the PCB and mercury concentrations of the dewatered sediments for purposes of disposal records and mass balance studies.

Samples of the dewatered sediment were collected from the front-end loader during loading of about every third truck (i.e., about every 60 wet tons). Ten consecutive sub-samples were considered a whole sample representing a batch of approximately 600 wet tons of dewatered sediment. Each of the ten sub-samples was sent to EnChem with a chain of custody form for compositing and analytical testing. Generally for the second, fifth, and eighth sub-samples, a second sub-sample was collected for physical testing in a field laboratory. Test results from the three sub-samples were averaged to represent each whole sample.

Analytical tests performed on each whole sample composited from ten sub-samples included paint filter (SW 846 9095A), percent solids (SM 2540G Mod), specific gravity (ASTM D854), PCBs (SW 846 8082), and mercury (SW 846 7471A). The laboratory percent solids results were used to compute dry tons of dewatered sediments for payment purposes. The laboratory emailed test results to Montgomery Watson as they were completed, which were forwarded to the WDNR and FRG. Validated data packages are in Montgomery Watson's Project files.

Physical tests performed in the field for operational quality control purposes included percent solids (weight of dry solids to total sample weight) (SM 2540B), moisture content (weight of water to dry weight of solids) (ASTM D2216), wet and dry density, and unconfined compressive strength using a hand-held torvane unit. Wet density was determined by placing the dewatered sediment at its field moisture into a 4-in. diameter Proctor mold (1/30-cf) using standard Proctor test methods (i.e., a 5.5-lb hammer, sediment placed in three layers, 25 hammer drops per layer; fewer hammer drops were used if the material was too wet). Torvane tests were performed on the ends of the Proctor mold after it was trimmed, before the sediment was extruded. Field test results were summarized in spreadsheets and emailed to members of the FRG and WDNR weekly.

4.4.7 Water Treatment WPDES Permit Monitoring

The water treatment system operations monitored by Montgomery Watson included the discharge flow rate, and sampling and analysis of the system influent and effluent, as required by the WPDES Permit. Table 2 of the WPDES Permit specified the monitoring requirements. Since carbon was used in the treatment process (i.e., tertiary treatment), several substances were able to be omitted from the monitoring program. The monitoring program and discharge limits are summarized as follows:

Effluent Limitations				**Monitoring Requirements**	
Parameter (Method)	**Daily Maximum**	**Weekly Average**	**Monthly Average**	**Sample Frequency**	**Sample Type**
Effluent: 001					
Flow (metered in MGD)	---	---	---	Daily	Continuous
BOD5 (SW846 5210)	---	<2 mg/L	---	1 x Weekly	Grab
TSS (EPA 160.2)	10 mg/L	---	5 mg/L	Daily	Composite
Ammonia N (EPA 350.1)	Monitor	---	---	Daily	Grab
Oil & Grease (SW846 1664)	10 mg/L	---	---	Daily	Grab
pH (field)	6.0 daily min. 9.0 daily max.	---	---	Daily	Grab
Mercury (EPA 1631)	1.7 ug/L	0.0026 lb/day	3.4E-5 lb/day	1 x Weekly	Composite
Total PCBs (SW846 8082)	---	---	1.2 ug/L 7.2E-3 lb/day	1 x Weekly	Composite
2,3,7,8-TCDD (SW846 8290)	---	---	3.0E-9 ug/L 1.8E-11 lb/day	1 x Weekly	Composite
Influent: 101					
TSS (EPA 160.2)	Monitor	---	---	Daily	Grab
Mercury (EPA 1631)	---	Monitor	---	1 x Weekly	Grab
Total PCBs (SW846 8082)	---	Monitor	---	1 x Weekly	Grab
Oil & Grease (SW846 1664)	Monitor	---	---	Daily	Grab
pH (field)	Monitor	---	---	Daily	Grab

In addition to the above routine monitoring, sampling and testing for priority pollutants was required on an effluent sample and a background river water sample soon after start-up. Similarly, a composite sample was required of the effluent for Whole Effluent Toxicity

(WET) testing, both acute and chronic. A sample of Fox River receiving water, outside this or other mixing zones, was also taken for use in the WET testing methods.

pH, turbidity, and flow were measured in the field. pH was measured with a portable instrument and turbidity was measured with the spare YSI 6820 turbidity sensor; both instruments were calibrated daily. The flow was measured by a flow meter, which displayed flow rate (gpm) and total flow (gal). With the exception of mercury and WET tests, the laboratory tests were performed for Montgomery Watson by EnChem or their subcontracted laboratory. Low-level mercury and WET tests were performed by the Wisconsin State Lab of Hygiene under contract to the WDNR. All laboratory samples were shipped with a chain of custody form.

Influent (101) and effluent (001) sample locations are shown on Drawings A6, A7, and A8. A pipe saddle was mounted on the effluent pipe downstream of the flow meter, which directed a sidestream of treated water through an automatic turbidity monitor into a 5-gal plastic container. A pH probe was mounted inside the 5-gal container. The 5-gal container overflowed to a larger plastic tub, which contained an electric submersible pump and float assembly to direct overflow back to the settling basins. Composite samples of the treated effluent were collected from the 5-gal container by a Manning automatic vacuum sampler provided by Montgomery Watson (Photo No. 20). Initially, the sampler was programmed to collect a sample aliquot for each 10,000 gal of flow. However, a consistent electronic signal from the flow meter was not able to be maintained, so the automatic sampler was re-programmed to collect an aliquot at 15 minute intervals, assuming a continuous flow of 600 gpm. The sample aliquots were discharged into a 2.5-gal glass jar inside a small refrigerator. Grab samples were collected from the 5-gal container. Low-level mercury effluent samples required the use of “clean hands” protocols. Four grab samples were collected from the 5-gal container (one about every six hours), which were flow-proportionally composited at the State Lab of Hygiene. When the weather conditions became colder, the effluent monitoring and sampling devices were moved inside a portable trailer next to the flow meter, and the tubing from the effluent pipe to the trailer was wrapped with electrical heating wire and insulation.

Initially, influent samples (101) were collected from a sample port in the influent piping, located between the equalization basins and the polymer/acid mix tank. After the supernatant and filtrate systems were separated for treatment on October 16, 1999, the influent sample point designation was changed to 101A, which represented basin supernatant after polymer addition and flocculation. The 101A influent samples were collected in the east equalization basin.

EnChem emailed test results to Montgomery Watson as they were completed, which were forwarded to the WDNR and FRG. These unvalidated results were used by Montgomery Watson to prepare the monthly discharge monitoring reports (DMRs) required by the WPDES Permit. Validated data packages are in Montgomery Watson’s Project files.

4.4.8 Inner Treatment Process Monitoring

In addition to required WPDES Permit monitoring, water quality grab samples were collected at various points within the water treatment system to allow evaluation of specific treatment system components, as well as optimization of operational parameters and system configuration. Process monitoring included daily measurement of pH and turbidity, and weekly sample collection for laboratory analyses of PCBs, mercury, and total suspended solids (TSS). Grab samples were collected from sample ports in the process piping. After the supernatant and filtrate treatment systems were separated, collection of weekly samples was alternated between each system to avoid doubling of analytical costs. Sample locations are shown on Drawings A6, A7, and A8, and were identified as follows:

Original Water Treatment System (up to October 16, 1999)

- P1 – After Chemicals (Polymer and Acid) and Flocculation/ Before Sand Filter
- P2 – After Sand Filters/ Before Granular Activated Carbon (GAC)
- P3 – Filter Press Filtrate

Supernatant Water Treatment System (after October 16, 1999)

- P5 – After Sand Filters/ Before GAC
- P6 – After GAC

Filtrate Water Treatment System (after October 16, 1999)

- P3 – Filter Press Filtrate
- P1 – After Acid and Equalization/ Before Sand Filter
- P2 – After Sand Filters/ Before GAC
- P4 – After GAC

The grab samples were sent to EnChem and the State Lab of Hygiene, similar to the WPDES samples, with a chain of custody form. EnChem emailed test results to Montgomery Watson as they were completed, which were forwarded to the WDNR and FRG. Validated data packages are in Montgomery Watson's Project files.

4.4.9 Other Sampling for Landfill Disposal Characterization

During demobilization activities in December 1999 and January 2000, media from the sand and GAC vessels were sampled and tested by EnChem for PCBs and percent solids. A separate representative sample from each vessel in the supernatant and filtrate treatment systems was collected and analyzed (total of six samples). The treatment media were hauled to the Fort James landfill and disposed with the dewatered sediments.

4.4.10 Dredge Slurry Monitoring

Montgomery Watson agreed to assist the FRRAT in collection of dredge slurry samples from the dredge pipeline before discharge to the equalization basins. A Manning automatic vacuum sampler, similar to the effluent water sampler but with larger diameter sample ports and tubing, was provided and installed near the southeast corner of the east basin

(Photo No. 21), just before the slurry discharge point. This was also the location where a slurry flow meter was installed. A pipe saddle was mounted near the top and bottom of the 12-in. diameter slurry pipe, with separate hoses joining together at the automatic sampler. When samples were not being collected, the sidestream slurry flow bypassed the automatic sampler through a hose leading to the east basin.

The sampler was wired to the slurry flow meter. The sampler was initially programmed to collect a representative aliquot of slurry for every 30 dry tons of sediment recorded by the mass flow meter (nuclear densometer). As noted previously, there were considerable problems maintaining the dredge slurry flow meter, and a consistent signal to the sampler was not able to be maintained. The sediment, and occasionally gravel and debris in the slurry, also regularly clogged the sampling hose and automatic sampler. Therefore, the FRRAT agreed that Montgomery Watson personnel would manually collect a dredge slurry sample periodically during dredging. As time allowed, the automatic sampler was manually turned on and off to collect an aliquot of dredge slurry in a 2.5-gal glass jar inside the refrigerated unit. The refrigerator held two glass jars, and generally a slurry sample was collected each day dredging was performed. USGS personnel came to the site throughout the week to pick up the slurry samples in the 2.5-gal jars. They processed each sample, and then returned the sample and cleaned jars. The slurry samples were submitted to EnChem with a chain of custody form for analyses.

At the laboratory, EnChem analyzed the various matrices as follows:

- Slurry: Mercury (SW846 7470A) and percent solids (SM 2540G Mod).

- Supernatant: PCBs (SW846 8082) and total suspended solids (EPA 160.2).

- Solids: PCBs (SW846 8082), percent solids (SM 2540G Mod), and specific gravity (ASTM D854).

EnChem emailed test results to Montgomery Watson as they were completed, which were forwarded to the WDNR and FRG. Validated data packages are in Montgomery Watson's Project files.

4.4.11 Pre-Dredge and Post-Dredge Monitoring

Monitoring before and after dredging included bathymetric surveys and sediment core sampling.

The WDNR contracted with the Corps of Engineers to perform a pre-dredge bathymetric survey, which was completed on August 23, 1999. Based on the information provided to Montgomery Watson, the Corps used a single-beam sonar to collect water depths on range lines spaced at 50-ft intervals in directions parallel and perpendicular to the shoreline across the Project area. Coordinate positions were determined with a GPS (Wisconsin State Plane, North American Datum 1983 (NAD83)). Depths were referenced to river elevation 576.8 (International Great Lakes Datum 1955 (IGLD55)).

The WDNR provided the Corps survey file to Montgomery Watson. The top of sediment elevations in IGLD were converted to Mean Sea Level Datum (National Geodetic Vertical Datum 1929 (NGVD29)) by adding 1.24 ft, according to instructions from the Brown County surveyor. The Corps pre-dredge sediment elevations were then contoured, and the topography is shown on Drawing A5. We compared this surface to the sediment topography in Montgomery Watson's March 1998 BODR, and found the surfaces to be very similar.

On August 19 to 21, 1999, just before the Corps' pre-dredge survey and installation of the silt curtain, Blasland Bouck & Lee (BBL) collected pre-dredge cores at the center of most of the subunits identified on Drawing A5. The cores were collected for the FRG and WDNR to provide additional pre-dredge physical and analytical characterization of the sediments in the Project area. Samples were analyzed for BBL by EnChem. Portions of the results were shared with Montgomery Watson during the middle to latter stages of the fieldwork, and a complete set of validated results was provided to us after dredging ended, during preparation of this report.

The FRG and WDNR contracted with Montgomery Watson to collect post-dredge cores in the subunits where dredging had occurred, as close as possible to the pre-dredge core locations. This sampling work was performed December 20 and 27, 1999, and January 7, 2000. Extremely cold temperatures and river ice hindered progress. Cores were taken at Subunits 12 through 17, 23 through 28, and 38 (13 locations). Duplicate cores were taken in Subunits 25 through 28 where a clean-up dredging pass had been completed in an approximately 30 ft by 30 ft area at the center of these subunits.

Montgomery Watson used a differential GPS to mark the BBL pre-dredge core locations (to within about 5 ft) in those subunits where survey maps showed dredging had occurred. The water depth was then sounded with the WDNR's custom sounding pole. Using the Project staff gage at the water intake, the post-dredge sediment elevation was computed, and it was compared to the pre-dredge sediment elevation. If the difference was more than approximately 1 ft, a post-dredge core was collected. Cores were collected through a center well in a 16-ft long, flat-bottom aluminum boat (Photo No. 22). Sampling tubes of 4-in. diameter Schedule 40 PVC were manually pushed into the sediment until refusal, and then were driven a few more inches with a sleeve hammer to seat the bottom of the tubes in firmer sediment. A piston assembly inside the sample tubes aided in sample recovery. Core samples were processed in a building on the former Shell Oil Company property in descending intervals from the top of 0 to 4 in., 4 to 12 in., and 1 ft intervals thereafter. The samples were sent to EnChem with chain of custody forms for analyses of PCBs (SW846 8082), mercury (SW846 7471A), percent solids (SM 2540G Mod), and total organic carbon (SW 846 9060M). Test results were provided to BBL, FRG, WDNR, and Montgomery Watson after validation by the Project data validator.

As a quality control check on dredge surveys conducted by FSE, Superior Special Services performed a survey to compute the volume of sediments dredged. This survey was performed on December 20, 1999 inside the silt curtain. Access to the dredge area was hindered slightly by the presence of the dredge, the dredge slurry pipeline, and one anchor barge, which had yet to be demobilized. Superior used an integrated system comprised of a 22-ft long climate-controlled boat (Photo No. 23); multi-beam sonar for determining water depth; differential GPS for establishing location; gyroscope for heading; motion reference unit for heave, pitch, and roll; and software package to provide a corrected coordinate data stream. Superior worked in NAD83 horizontal datum and NGVD29 vertical datum. Montgomery Watson provided them with the Corps pre-dredge survey file and base maps from the BODR.

Superior prepared full-size color drawings showing the Corps pre-dredge sediment topography, their post-dredge sediment topography, cross-sections, and a 3D perspective digital terrain model. An electronic file and one complete drawing set were provided to the FRG and WDNR for their records. Due to their size, the full-size drawings are not included in this summary report. However, we used Superior's post-dredge data set (x,y,z file) to prepare a smaller scale post-dredge topographic map – see Drawings A10 and A10a. The approximate actual limits of dredging are outlined on these drawings. We also prepared a dredge thickness isopach map, by subtracting the post-dredge elevations from pre-dredge elevations – see Drawings A11 and A11a. Observations from these drawings and computed dredge volumes are discussed in Section 5.0 of this report.

4.5 DEMOBILIZATION

As noted previously, dredging was discontinued on December 15, 1999 because of the onset of winter weather conditions. Low temperatures in the latter stages of the Demonstration Project required operating adjustments for all aspects of the hydraulic dredging, water treatment, and dewatering, because of freezing water in the pipelines and process equipment, as well as the formation of river ice.

Partial Project demobilization was performed between December 15, 1999 and January 19, 2000, including:

- Treatment and river discharge of all but approximately 0.5 to 1.0 ft of water in the east and west equalization basins. Due to cold conditions, it was impractical to remove the last portion of dredged solids from the west equalization basin (rough estimate of 3,000 cy), and a thin layer of water treatment settled solids in the east basin. Therefore, both basins were then covered with a temporary polyethylene cover, weighted down at the top of the perimeter berm.

- Removal of the production river dredge, the cutterhead dredge used as an anchor barge, and the other anchor barge.

- Removal of the water treatment system, including tanks, pumps, controls and most of the filter media and carbon.

- Removal of the lime storage and feed system, filter press feed tanks, filter presses, and filtrate tank.

- Removal of the truck scale and job trailers.

- Removal of the real-time river turbidity monitoring equipment.

The dredges, water treatment system and dewatering system tanks, and the filter presses were pressure washed on the asphalt pad prior to demobilization from the site. Because the water treatment system and filter presses had been decommissioned, the wash water and solids were collected from the sump and transferred to the west equalization basin for temporary storage over the winter, before the basin was covered.

Montgomery Watson made periodic site visits during the winter and spring months to check the standby conditions of the Shell property and the items left in the river (i.e., silt curtain, dredge slurry piping, and piling used for the turbidity monitoring system). Batteries in the lights on the monitoring piling and silt curtain were replaced after ice-out in the spring.

On May 26, 2000, the USEPA, WDNR, and Fort James finalized an Administrative Order by Consent under Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), to perform additional dredging at SMU 56/57. As a result, the WDNR and Fort James decided the silt curtain should not be removed so that it could possibly be re-used during the additional dredging activities. For the same reasons, Fort James decided that Montgomery Watson should not remove the asphalt work pad, gravel roads and parking areas, the equalization basins, and the temporary electrical service at the Shell property during the completion of demobilization.

Demobilization activities for the Demonstration Project were subsequently re-initiated on June 12, 2000 and substantially completed on July 24, 2000. This remaining work included:

- General site clean-up along the Fort James shoreline and on the former Shell Oil Company property, including removal of remaining equipment and supplies from the vacant building on the Shell property.

- Removal from the river the monitoring piles (Photo No. 24), dredge slurry pipeline, and water treatment discharge pipeline. The piling were salvaged by the subcontractor who installed them for Montgomery Watson. The piping was salvaged by FSE, the Project subcontractor for dredging, dewatering, and water treatment operations.

- Removal from the Shell property all process piping, which was salvaged by FSE.

- Removal of remaining limited construction materials and water treatment media from the asphalt work pad, which were trucked and disposed at the Fort James landfill (Photo No. 25).

- Removal and disposal of the temporary cover over the two equalization basins, and pumping out the water for treatment. Water treatment was performed using a scaled-down solids removal system, similar to the process used the prior fall during dredging. Water was pumped into a 20,000-gal portable equalization tank for initial settling (primary treatment), from which it was pumped through a manifold of three bag filters connected in parallel (secondary treatment), and then through two portable carbon vessels connected in parallel (tertiary treatment). Treated water was pumped into a second portable 20,000 gal storage tank (Photo No. 26). The treatment system was sized for a flow rate of approximately 100 to 150 gpm. Because the Project WPDES Permit had expired on December 31, 1999, WDNR approved transporting the treated water to the Fort James Mill using a tank truck, where it was discharged to the Mill wastewater collection system (Photo No. 27). Wastewater at the Mill is treated and discharged to the Fox River under the Mill's WPDES Permit.

- Removal of the sediments and settled solids from the equalization basins, followed by the underlying geomembrane liners. A combination of backhoes, high pressure water hoses, and manual labor were used to remove the solids. Prior to removal, the materials were solidified, as necessary, with the addition of lime so the material would pass paint filter testing (Photo No. 28). These tests were performed daily as a backhoe mixed the lime and loaded the trucks (Photo No. 29). A representative sample of material was taken as each truck was loaded. These samples were shipped to EnChem's laboratory for compositing and testing (PCBs, mercury, percent solids, specific gravity), at the same frequency as the work the prior fall. The basin HDPE liners were cut up and also loaded into the trucks, along with the top few inches of the underlying clay liner (Photo No. 30). The trucks were visually inspected and then tarped, after which they drove a short distance to the Fort James West Mill to be weighed on Fort James' truck scale. Each truck load was manifested for disposal at the Fort James landfill. Including the 249 truck loads of solidified sediment and other Project wastes during Project demobilization, a total of 1,489 loads were disposed at the Fort James landfill for the SMU 56/57 Demonstration Project.

- Final pressure washing of the water treatment system components, equipment used to excavate sediment from the basins (Photo No. 31), the asphalt work pad and sump, and discharge of the collected water at the Fort James Mill. While pumping out the sump for cleaning, water was observed flowing back into the sump through the joint between the concrete lid and and underlying section of manhole. As a result, a decision was made to pull out the sump, and the surrounding backfill was excavated (Photo No. 32), manifested, and hauled to the Fort James landfill. The concrete manhole of the sump was salvaged by Fort James.

- Sampling of the remaining basin clay liners, surface soils around the asphalt pad, and the sump backfill, for PCBs and mercury testing. This work was done by a consultant of Fort James to check for potential Project-related impacts. As a result, a small amount of surficial soil (four trucks totaling 67 tons) adjacent to the asphalt pad, found to contain PCBs ranging from 0.3 to 3.9 mg/kg, was excavated on November 20, 2000 and disposed at the Fort James landfill.

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5.0 PROJECT PERFORMANCE

This section of the Summary Report provides performance results of the construction and monitoring activities. Table 1 summarizes the Project metrics, which are discussed throughout the following sections.

5.1 DREDGING

5.1.1 Volume of Sediment Removed

Figures 2 and 3 show dredge volumes over the course of the Project. Figure 2 shows the dredge volumes computed between dates of bathymetric surveys, and Figure 3 shows the cumulative dredge volume, totaling 31,346 cy. The dredge volumes during the course of the Project were reported by Four Seasons Environmental (FSE) based on their periodic surveys, whereas the final dredge volume was computed by Superior Special Services comparing the Corps pre-dredge survey data (Drawing A5) with Superior's post-dredge survey data (Drawings A10 and A10a). Montgomery Watson performed an independent dredge volume calculation using the pre- and post-dredge survey data, and arrived at a figure 2.4% higher than Superior's calculation, which is considered reasonable precision. We also calculated the volume of sediment within the dredge limits depicted on Drawings A10 and A10a, using the GIS model described in the May 1998 Basis of Design Report (BODR). This area contained an estimated 38,670 cy of sediment, assuming vertical cuts at the outer limits and dredging to the originally established target elevation 565.

5.1.2 Dredge Production

Daily dredging hours over the course of the Project are shown on Figure 4. Between August 30 and December 15, 1999, dredging occurred on 96 of 108 calendar days, averaging 4.3 hours per day. The reported cumulative dredging time was 464.5 hours as shown on Figure 5. Average dredging production rates were monitored over the course of the Project, by dividing cumulative dredge survey volumes by cumulative dredge hours. River bottom surveys were not performed immediately before and after the clean-up pass dredging, so production results differentiating between mass removal and clean-up are not available.

Figure 6 shows that the average hourly dredging rate over the course of the Project was 60 cy/hour, below the goal of 200 cy/hour. The highest cumulative rate achieved was 90 cy/hour. Figure 7 shows the average daily dredging rate was 294 cy/day, below the goal of 900 cy/day. The highest cumulative rate achieved was 473 cy/day. The highest cumulative rates are based on the sediment volume (6,155 cy) dredged between the start of the Project and the first available river survey on September 16, 2000 (68 hrs of dredging over 13 days). The figures show the initial higher average dredge rates were not sustainable. Higher dredge rates were achievable early on, in part, because the dredge was able to crowd the horizontal auger cutterhead into the sediment, whereas later on the dredge pumped more water while overlapping adjacent dredge tracks.

Based on the total measured dry tons of sediment dredged and the total measured volume of water treated and discharged back to the river (these figures are discussed later), the average percent solids in the dredge slurry was 4.4%. The goal for solids content of the dredge slurry was 7.5%.

5.1.3 Turbidity Near the Dredge

Montgomery Watson made manual turbidity measurements near the dredge periodically during the course of the Project, as time allowed, to supplement real-time monitoring by the fixed instrumentation. Measurements were made at a depth six-tenths of the water depth (0.6D). Of the data collected and reviewed, there were eight dates when turbidity measurements were taken during, or within a one-hour period after, dredging at locations both upstream and downstream of the dredge. The dates meeting these criteria were September 25, 29, and 30, 1999 (Figure 8); October 1, 24, and 30, 1999 (Figure 9); and November 7 and 12, 1999 (Figure 10). Manual turbidity measurements on other dates either were taken before dredging began or more than one hour after it had started, or did not include an upstream measurement for comparison of dredging effects on sediment resuspension. One hour was chosen as a limiting criterion in data review, because downstream turbidity measurements were made no further than 300 ft from the dredge, a distance that would have been impacted by resuspension based on measured river velocities. The measured river velocity on these dates was generally between 0.1 and 0.2 fps, which means a sediment particle re-suspended by dredging could travel a distance of 360 to 720 ft in one hour.

The three figures, with one exception, indicate that turbidity downstream of the dredge was higher than turbidity upstream of the dredge. The amount of the increase, and the distance downstream of higher turbidity, varied. The one exception is on Figure 8 for measurements on September 29, 1999. On this date and time, the turbidity 10 ft upstream of the dredge was higher than measured turbidity 20 to 100 ft downstream of the dredge. The turbidity value 20 ft downstream (150 NTU) was only slightly less than the value 10 ft upstream (170 NTU), however.

5.1.4 Turbidity Inside and Outside the Silt Curtain

Thousands of turbidity measurements were recorded by the real-time monitoring system at each of six locations in the river (see Drawing A5) to check for potential sediment re-suspension due to dredging:

- Upstream of the dredge area outside the silt curtain (USO).
- Upstream of the dredge area inside the silt curtain (USI).
- Sidestream of the dredge area outside the silt curtain (SSO).

- Downstream of the dredge area outside the silt curtain (DSO).

- Downstream of the dredge area inside the silt curtain (DSI).

- Fort James water intake (FJI).

Values were recorded at 15-minute intervals whether or not dredging was occurring. All of the data was reviewed. Some data points were omitted, if it was determined the results were erroneous due to turbidity sensor malfunction. A very limited few additional data points were omitted, if they were many times greater than the data point 15 minutes before and 15 minutes after the anomalous point for no apparent reason (i.e., unrelated to a dredging period). (For example, for the DSO data set, about 1% of 9,300 data points were not used, and for DSI, about 4% of 7,700 data points were not used, for the reasons stated.) Monthly averages are summarized as follows for each location.

Location	Average Turbidity (NTUs)				
	Aug-99	**Sep-99**	**Oct-99**	**Nov-99**	**Dec-99**
FJI	46	46	29	31	16
USO	46	40	21	18	9
USI	49	44	24	21	16
SSO	43	35	21	20	11
DSO	41	33	25	22	20
DSI	38	35	31	33	20

Observations from this table include:

1. At each location, the average turbidity generally declined in successive months.

2. From month to month, the maximum difference in average turbidity between all six locations only varied slightly (by 10 to 15 NTUs).

3. In a given month, the average turbidity at locations outside the silt curtain was not appreciably different, regardless of position relative to the dredge or normal river flow direction.

4. From month to month, the average turbidity inside the silt curtain changed from being higher upstream to downstream, and vice versa, but the differences were not appreciable (from 4 to 12 NTUs).

5. In a given month, the average turbidity inside the silt curtain was generally slightly higher than its adjacent outside monitor, but the differences were not consistent or significant (e.g., relative to outside the silt curtain, average turbidity inside ranged from 3 NTUs lower to 11 NTUs higher). These differences were not that significant considering the accuracy of the monitoring devices ($\pm$ 2 NTU).

The real-time turbidity data was plotted for each monitoring location in monthly and weekly periods, resulting in numerous figures. The dredging periods were noted on each figure. USO/USI data and DSO/DSI data were plotted together for ease of comparison. For examples of the figures, the October monthly and weekly charts for DSO/DSI are included herein. On the figures for DSO/DSI only, we also noted the periods when Fort James received coal boat deliveries to evaluate whether prop wash during docking of the boats may have caused elevated turbidity.

Figure 11 is the DSO/DSI monthly chart for October 1999. Note that dredging occurred at regular intervals throughout the month, and Fort James received six coal boats. At this scale, it is difficult to ascertain any significant differences in turbidity between the monitors inside and outside the silt curtain, or during periods of dredging and coal boat delivery. (Note that the vertical scale was kept the same at each of the six monitoring locations to simplify comparisons, which is not evident when viewing this limited data set.) Differences, if any, are more evident, however, when isolating the data to a given week, as shown on Figures 12 through 15.

For example, on Figure 12 for the period of October 1-8, the DSO and DSI turbidity readings were relatively the same for the entire week. However, on October 5, the turbidity at DSI was slightly elevated compared to DSO during, and/or following, a period of dredging. The dredge was positioned approximately 700 ft upstream of the silt curtain at this time. On Figure 15 for the week of October 25-31, the DSI turbidity was slightly higher than DSO for the entire week, regardless of whether dredging was occurring. Slightly higher turbidity is evident at DSO compared to DSI on several days when coal boats made deliveries: October 5-6, October 8, and October 25. Conversely, on October 24 the DSO turbidity was lower than DSI during a coal boat delivery.

In summary, the evaluation of manually-collected turbidity data generally showed that turbidity downstream of the dredge was higher than upstream of the dredge. On the other hand, the evaluation of extensive real-time turbidity data within and outside the silt curtain showed inconsistent, and generally insignificant, differences. The data indicates dredge-induced turbidity was minimal to negligible at a distance tens of feet to a few hundred feet from the dredge. Often the dredge-induced turbidity near the silt curtain could not be readily discerned from the background variability of turbidity during non-dredge periods.

5.1.5 Dredge Slurry Test Results

The results of tests on samples of the dredge slurry from the environmental monitoring program are summarized below. Note that a value of zero was used for all statistical calculations in this report when a test result indicated a parameter was undetected. Ranges in detection limits, as reported by the analytical laboratory, are also summarized below.

Matrix	Parameter	Units	Detection Limit	Average	Minimum	Maximum	Count
Slurry	Mercury	ug/L	0.21-3.4	46.7	4.9	570	76
	Total Solids	%	---	2.6	0 (1 value)	11.4	68
	TSS	mg/L	29-350	25,931	1,200	200,000	77
Solids	PCBs	ug/kg	100-5,200	56,849	700	260,000	74
	Total Solids	%	---	21.8	9.7	45.2	74
	Specific Gravity	---	---	2.57	2.13	2.96	76
Supernatant	PCBs	ug/L	1.7-660	214	0 (5 values)	8,800	76
	TSS	mg/L	2.8-290	3,107	46	180,000	76

As shown, the average percent solids of the slurry samples was 2.6% compared to the back-calculated percent solids of 4.4% for dredge slurry as described in Section 5.1.2. The back-calculated figure is likely more representative, because of the dredge slurry sampling problems described in Sections 4.4.4 and 4.4.10, which may have biased the percent solids of slurry samples on the low side. The percent solids of dredge slurry samples averaged 3.9% percent solids in the first two months of dredging and 1.7% in the last one and one-half months. These measured results show higher solids when the dredge is able to “crowd” the sediment during initial dredge passes, and lower solids when the dredge pumps more water during thinner cuts and overlap of adjacent dredge tracks.

5.2 WATER TREATMENT

5.2.1 Influent Test Results

The results of tests on the influent water (basin supernatant) to the water treatment system (sample point 101/101A) are summarized below. Note that a value of zero was used for all statistical calculations when a test result indicated a parameter was undetected. Ranges in detection limits, as reported by the analytical laboratory, are also summarized below.

Parameter	Units	Detection Limit	Average	Minimum	Maximum	Count
PCBs	ug/L	0.2-1.7	4.8	0.65	34	15
Mercury	ng/L	0.1	71	0 (3 values)	546	15
TSS	mg/L	0.2-290	66	0 (2 values)	3,300	100
Oil & Grease	mg/L	1.4	3.9	0 (23 values)	9.5	101
pH	su	---	8.4	5.2	12.6	102
Turbidity	NTU	---	58	0 (1 value)	810	94

5.2.2 Effluent Test Results

The results of tests on the treated effluent before discharge to the Fox River are summarized below. Note that a value of zero was used for all statistical calculations when a test result indicated a parameter was undetected. Ranges in detection limits, as reported by the analytical laboratory, are also summarized below. Test results are plotted by sample date on the referenced figures, except for dioxins that were undetected. Each figure notes that through October 16, 1999 the basin supernatant and filter press filtrate were combined for treatment. After October 16, 1999, the supernatant and filtrate were treated in separate process systems.

Parameter	Units	Detection Limit	Average	Minimum	Maximum	Count	WPDES Limit	Reference Figure
PCBs	ug/L	0.33	0.02	0 (14 values)	0.37	15	1.2	16
Mercury	ng/L	0.1	16.5	0 (1 values)	101.8	19	1,700	17
TSS	mg/L	0.2-16	7.3	0 (6 values)	280	102	10	18
Oil & Grease	mg/L	1.4	3.4	0 (24 values)	8.3	102	10	19
pH	su	---	7.5	6.0	10.8	101	6-9	20
Turbidity	NTU	---	1.2	0 (30 values)	22	94	---	21
BOD5	mg/L	2.0	11.5	0 (3 values)	27	19	2.0	22
Ammonia N	mg/L	0.012-1.2	16.7	1.6	49	102	---	23
Dioxins	pg/L	1.6-7.1	0	0 (all values)	0	15	---	---

As shown on Figure 16, PCBs were detected in only one weekly effluent sample, and the result of 0.37 ug/L was below the WPDES Permit monthly average limit of 1.2 ug/L. Total PCBs are reported in the tables and figures, although only Aroclor 1242 was detected in the one sample.

Figure 17 shows that the mercury concentration of 101.8 ng/L in the first weekly effluent sample was considerably higher than subsequent samples. All test results were well below the WPDES Permit daily maximum limit of 1,700 ng/L.

The table above includes the total suspended solids (TSS) results of all daily samples. As noted, TSS concentrations shown on Figure 18 exclude one result of 280 mg/L, which is anomalous compared to the other data. Without this value, the maximum measured concentration drops to 42 mg/L, and the average drops to 4.6 mg/L. Considering all results, the WPDES Permit daily maximum limit of 10 mg/L was exceeded six times in the first five weeks of operation. After learning of the results and diagnosing possible causes for periodic high values, the diversion valve and piping on the effluent line, used to circulate water back to the basins, was relocated upstream of the automatic sampler. Water was diverted back to the basins for re-treatment instead of to the river if the pH and/or turbidity sensors indicated upset conditions. Flow was also diverted to the basins during periodic back-flushing of the sand and carbon treatment vessels. Before October 7, 1999 during these diversion periods, the automatic sampler continued to pull samples from the flow stream, biasing the TSS results. After relocating the diversion piping, daily TSS results were consistently below the Permit limit, until two exceedances in the last few days of operation. Because of lab turnaround time, these last two exceedances were unknown until after operations ended.

Figure 19 shows that daily oil and grease concentrations were below the Permit limit of 10 mg/L for all samples.

Figure 20 shows that the field pH in daily grab samples was within the Permit range of 6 to 9, except for one measured value of 10.8 on September 28, 1999. For comparison on this day, the composite sample collected by the automatic sampler had a pH less than 9.

Figures 21 and 23 show field turbidity and laboratory ammonia nitrogen test results, respectively. No Permit limits were established for these parameters, but monitoring was still required.

BOD_5 results shown on Figure 22 indicate that the Permit weekly average limit of 2 mg/L was exceeded, except for three samples when no BOD_5 was detected. In accordance with the Permit requirements, additional BOD_5 samples were collected and analyzed on two occasions when the exceedances became known. The results of the additional samples were still above the Permit limit. The results were discussed with the WDNR and FRG in weekly construction meetings, and it was agreed to continue treatment system operation and weekly monitoring without interruption or process modifications to the treatment system.

With the exception of BOD_5, the Project was successful in meeting WPDES Permit limits; minor exceedances were readily corrected with changes and adjustments to the treatment systems.

The daily volume of water discharged from the treatment system to the Fox River is shown on Figure 24. Before the treatment system capacity was expanded, the average daily discharge was 385,700 gal (i.e., average 268 gpm, assuming continuous operation). When the expanded capacity became operational after October 16, 1999, the average daily discharge volume increased to 886,600 gal (i.e., average 616 gpm, assuming continuous operation). Cumulative discharge volume is plotted on Figure 25, and indicates a total of 75,256,500 gal of water were treated and discharged to the river over the course of the Project. During demobilization activities in June and July 2000, an additional 957,400 gal of water were treated and discharged to the process water system at the Fort James West Mill, not directly to the river. The total volume of water treated during the Demonstration Project was 76,213,900 gal.

5.2.3 PCB and Mercury Mass Discharged to the River

PCB and mercury concentrations of weekly samples, together with the volume of water discharged to the river between each sample, were used to compute the mass of PCBs and mercury discharged to the river in the treated effluent. Figure 26 shows a cumulative mass of 0.028 lb of PCB was discharged to the river over the course of the Project (only one sample detected PCBs). Figure 27 shows a cumulative mass of 0.0076 lb of mercury was discharged to the river in the treated effluent.

5.2.4 Treatment Process Evaluation

Additional water samples were collected and tested from various points in the treatment systems to provide data for evaluating which steps provided the best treatment efficiency. These results could be considered in potential future sediment removal projects on the lower Fox River. Since PCBs are the primary contaminant of concern, they were used for this evaluation. The results are summarized below for the original water treatment system, the basin supernatant water treatment system, and the filter press filtrate water treatment system. It should be noted that the granular activated carbon in the original carbon vessel (about 10 tons) was replaced within a few days of Project start-up due to inadvertent solids clogging. Thereafter, the media in the sand filter and carbon vessels (about 10 tons each) were periodically back-flushed with water, as needed, during the course of the Project, but were not changed out until Project demobilization and final disposal in the Fort James landfill.

<u>Original Water Treatment System (up to October 16, 1999)</u>

101 – Basin Supernatant
P1 – After Chemicals (Polymer and Acid) and Flocculation/ Before Sand Filter
P2 – After Sand Filters/ Before Granular Activated Carbon (GAC)
P3 – Filter Press Filtrate
001 – Treated Effluent

Original Water Treatment System									
Sample Date	**PCBs (ug/L)**					**Treatment Step Reduction (%)**			
	101	**P3**	**P1**	**P2**	**001**	**P1/101 Chem&Floc**	**P1/P3 Chem&Floc**	**P2/P1 Sand**	**001/P2 Carbon**
9/8/99	10	1.5	6.0	4.7	0	40%	-300%	22%	100%
9/16/99	2.7	1.0	2.1	1.6	0	22%	-110%	24%	100%
9/21/99	3.6	2.5	2.7	2.3	0	25%	-8%	15%	100%
9/28/99	34	1.8	2.9	1.8	0	91%	-61%	38%	100%
10/5/99	2.9	1.9	2.4	2.1	0	17%	-26%	13%	100%
10/13/99	1.5	2.4	2.5	2.0	0	-67%	-4%	20%	100%
Average	9.1	1.9	2.5	2.4	0.0	22%	-85%	22%	100%

Supernatant Water Treatment System (after October 16, 1999)

101A – Basin Supernatant after Polymers and Flocculation/ Before Sand Filters
P5 – After Sand Filters/ Before GAC
P6 – After GAC
001 – Treated Effluent

Supernatant Water Treatment System						
Sample	**PCBs (ug/L)**				**Treatment Step Reduction (%)**	
Date	**101A**	**P5**	**P6**	**001**	**P5/101A Chem/Floc & Sand**	**P6/P5 Carbon**
10/19/99	1.4	0.0	0.0	0.0	100%	---
11/02/99	0.89	0.0	0.0	0.0	100%	---
11/23/99	3.2	0.0	0.0	0.0	100%	---
12/07/99	0.65	0.46	0.0	0.0	29%	100%
12/16/99	1.6	1.2	0.0	0.0	25%	100%
Average	1.6	0.4	0.0	0.0	64%	100%

Filtrate Water Treatment System (after October 16, 1999)

P3 – Filter Press Filtrate
P1 – After Acid and Equalization/ Before Sand Filter
P2 – After Sand Filters/ Before GAC
P4 – After GAC
001 – Treated Effluent

Filtrate Water Treatment System								
Sample	**PCBs (ug/L)**					**Treatment Step Reduction (%)**		
Date	**P3**	**P1**	**P2**	**P4**	**001**	**P1/P3 Chem&Floc**	**P2/P1 Sand**	**001/P2 Carbon**
10/26/99	4.9	2.3	1.6	---	0	53%	30%	100%
11/09/99	2.2	4.5	2.8	---	0	-105%	38%	100%
11/16/99	7.9	4.6	2.5	---	0	42%	46%	100%
12/01/99	1.3	1.9	1.8	---	0.37	-46%	5%	79%
Average	4.1	3.3	2.2	---	0.1	-14%	30%	95%

A review of this data indicates that the polymer addition and flocculation step had mixed results for PCB reduction. This step did little for the filtrate PCB removal, but it removed a considerable amount of PCBs from the supernatant. The next step of dual media (i.e., sand) filters removed a large percentage of the PCBs, but the final carbon step was essential to remove the balance of the PCBs in order to meet the WPDES Permit limit of 1.2 ug/L.

5.2.5 Treatment Media Residual PCB Concentrations

PCB results of representative treatment media samples taken during Project demobilization are summarized below. These results confirm that the carbon captured considerably more PCBs than the sand.

Sample Date	Media	PCB (ug/kg)
12/16/99	Supernatant Sand 1	3,300
12/20/99	Supernatant Sand 2	1,600
12/20/99	Supernatant Carbon	19,000
1/11/00	Filtrate Carbon	21,000
1/13/00	Filtrate Sand 1	1,600
1/13/00	Filtrate Sand 2	1,800

5.3 DEWATERING

5.3.1 Dewatered Sediment Physical Test Results

A summary of physical test results, (43 composite samples) on the sediment dewatered in the filter presses, are summarized below. As shown, the percent solids measured in the field laboratory were essentially the same as measured in the analytical laboratory; the analytical laboratory results were used to compute dry tons of sediment. The average value of 53.1% fell below the goal of 58% established by the dewatering subcontractor. For all samples, the dewatered sediment passed the paint filter test (i.e., contained no free liquids). The average shear strength was below the goal of 0.4 tsf. Lower shear strength results correlated with lower percent solids and higher moisture content. Occasionally in these instances, the dewatered sediment was more difficult to manage at the landfill. Normally, the dewatered sediment could be unloaded from the trucks at the landfill and spread with a wide track bulldozer.

Parameter	Units	Average	Minimum	Maximum
Field:				
Total Solids	%	52.7	45.7	61.1
Moisture Content	%	90.2	45.2	137.5
Wet Density	pcf	87.7	79.8	101.7
Dry Density	pcf	47.0	33.6	86.7
Shear Strength	tsf	0.36	0.18	0.56
Laboratory:				
Paint Filter	---	Pass	Pass	Pass
Total Solids	%	53.1	46.7	62.3
Specific Gravity	---	2.60	2.41	2.76

The above data excludes the sediments excavated from the equalization basins during demobilization activities in June and July 2000. The sediments in the equalization basins were not dewatered in filter presses, but rather solidified with lime prior to disposal at the Fort James landfill. These materials were field tested for paint filter (all samples passed), but not percent solids, moisture, density, or strength. The analytical laboratory results for percent solids of these solidified sediments ranged from 53.8% to 67.6%, and averaged 61.1%.

5.3.2 Mass of Sediment Landfilled

Figure 28 shows the cumulative wet mass (weight) of dewatered sediments disposed at the Fort James landfill in 1999. The total of 26,838 wet tons through December 20, 1999 is based on a daily summation of scaled net weights reported on the waste manifest forms for each truck. These totals include the weight of dry hydrated lime that was added to condition the dredge slurry before filter pressing. An additional 89 wet tons of water treatment filter media were hauled to the landfill on January 14 and 17, 2000. During demobilization activities in June and July 2000, an additional 3,893 wet tons of sediment solidified with lime, and 972 wet tons of other Project wastes (e.g., basin clay and HDPE liner materials, water treatment carbon) were landfilled. Therefore, the total mass of sediment and other Project wastes disposed at the landfill was 31,792 wet tons. According to records maintained by Fort James, the total volume of sediments and other wastes from the Demonstration Project that were placed in Cell 12A of their landfill was 27,600 cy. This is based on before and after surveys, and excludes interim cover and access roadway aggregate. The net in-place wet density of all materials disposed in the landfill then computes to 85 lb/cf.

Figure 29 shows the cumulative dry mass (weight) of landfilled sediments. Laboratory percent solids results were used to compute the dry mass, which totaled 14,335 dry tons through December 20, 1999. This total includes lime added during dewatering (2,598 dry tons), as well as the weight of a carbon vessel replaced at the start of the Project (estimated 10 dry tons) and treatment media from the supernatant water treatment system removed during preliminary demobilization (estimated 31 dry tons) in December 1999. While completing demobilization activities in June and July 2000, 2,344 dry tons of solidified sediment (including 333 dry tons of lime) was landfilled, based on laboratory percent solids data. Therefore, the net dry weight of dredged sediment, excluding lime and other Project wastes, that was dewatered and hauled to the landfill, was approximately 13,707 dry tons. As noted earlier, payment for dewatering was based only on dry tons of sediment, excluding lime and other Project wastes that did not go through the dewatering or solidification processes.

5.3.3 Sediment PCB and Mercury Concentrations

Average PCB and mercury concentrations of the dewatered sediments are summarized in the following table. The results of individual samples are plotted by date on Figures 30 and 31, respectively.

Parameter	Units	Detection Limit	Average	Minimum	Maximum	Count
PCBs	mg/kg	0.22-5.3	44.4	15.0	110.0	50
Mercury	mg/kg	0.0031-0.025	0.92	0.42	1.60	50

The average PCB concentration of 50 samples over the course of the Project was 44.4 mg/kg, under the TSCA limit of 50 mg/kg. However, 18 of the samples had results ≥50 mg/kg, representing approximately one-third of the total dry mass of sediment disposed at the Fort James landfill. Only Aroclor 1242 was detected in the dewatered sediments, which was consistent with prior core sampling and PCB testing of the in-river sediments. As expected based on results in the May 1998 Basis of Design Report (BODR), Figure 30 indicates the highest PCB concentrations were from sediments dredged in the northern extent of the Project area, where dredging began and ended. Figure 31 indicates the mercury results were also higher in the northern area.

5.3.4 PCB and Mercury Mass Removed by Dredging

PCB and mercury concentrations of the dewatered sediment samples, together with the calculated dry mass of dewatered sediment represented by each sample, were used to determine the mass of PCBs and mercury removed from the river by dredging. Figure 32 shows that an estimated 1,326 lb of PCBs were removed during dredging in 1999, and 111 lb of PCBs were calculated to be excavated from the equalization basins during demobilization activities in 2000. An estimated additional 1 lb of PCB was captured in the water treatment filter media. An estimated 3 lb of PCBs were contained in other Project wastes, for an overall total of 1,441 lb of PCBs removed by dredging.

According to the Environmental Monitoring Report (Blasland, Bouck & Lee; July 2000), an estimated 22 kg or 48 lb of PCBs were lost to the river during dredging based on water column sampling (i.e., 3.3% of the total PCB mass removed by dredging). This Report also estimated that less than 1 lb of PCB was released to the atmosphere during the course of the Demonstration Project. The estimated PCB mass removed by dredging or lost to the environment then totals 1,490 lb.

Figure 33 shows that an estimated 27.8 lb of mercury were removed from the river during dredging in 1999, and 2.4 lb of mercury were excavated from the equalization basins during demobilization activities in 2000. An estimated 0.1 lb of mercury was contained in other Project wastes, for an overall total of 30.3 lb of mercury removed by dredging. This amount does not include the water treatment filter media, which were not tested for mercury prior to disposal at the Fort James landfill.

5.4 DREDGE AREA CONDITIONS

Dredging to elevation 565 was the goal before work began. Elevation 565 was selected during the procurement work phase to remove sediments with expected PCB concentrations $\geq$1 mg/kg, based on the GIS model described in the May 1998 Basis of Design Report (BODR). Based on actual conditions in a few locations of the subunits, the dredge penetrated the generally dark, soft organic silty sediment before reaching elevation 565. In these locations, which were not uniform across the dredge area, the dredge generally encountered a red-brown clay stratum and/or sand lenses. As a result, the dredge was allowed to stop dredging above the target elevation in these locations to avoid the dredging of uncontaminated materials.

In middle November 1999 when it became apparent work would have to be discontinued soon due to the onset of winter weather, raising of the dredge target elevation was discussed in weekly construction meetings with the WDNR and FRG. After review of preliminary PCB results from August 1999 pre-dredge cores obtained for the environmental monitoring program, the FRG and WDNR agreed to raise the target elevation to 567. Based on progress at the time, this target was in effect for approximately the northern one-half of Subunits 14 and 25 and all of Subunits 13 and 24 (Drawing A5). The pre-dredge cores from the center of these four subunits indicated PCB concentrations should be $\leq$ 1 mg/kg at elevation 567 (Table 2). At the end of November based on slower than expected progress, it was agreed to raise the target again, to elevation 568 in Subunits 12 and 23. Based on pre-dredge cores (Table 2), the PCB concentrations in the center of Subunits 12 and 23 at Elevation 568 should have been $\leq$ 3.5 mg/kg.

Drawing A10a shows the post-dredge sediment topography in the dredge area. In the southern two-thirds of the dredge area where the target elevation was 565, elevations vary from about 562 to 568. In the northern one-third of the dredge area where the target was 567 to 568, the elevations vary from about 567 to 572. The northeastern limits of dredging (e.g., east half of Subunit 23) had the least amount of sediment removed.

The irregular shapes of the contour lines in all areas dredged are evidence of ridges left by the dredge during the production dredging phase. Ridges are not uncommon after hydraulic (or mechanical) dredging. Due to time restrictions, a clean-up pass, which was originally planned for the entire area dredged, was only performed in a 30 ft by 30 ft area at the center of Subunits 25, 26, 27, and 28. As described in Section 4.1.3.2, the purpose of a clean-up pass is to remove contaminated sediments that potentially were re-suspended and subsequently re-settled in the dredge area, as well as potential undredged ridges between dredge tracks. The target elevation for the clean-up pass was 6 in. below elevation 565 (i.e., elevation 564.5), or shallower if the soft silty sediments were penetrated.

Drawing A11a shows dredge thickness isopach lines. These were determined by comparing pre-dredge (Drawing A5) and post-dredge (Drawing A10) top of sediment surfaces. Dredge cuts were a maximum of about 10 ft in the southern limits of the work area. As shown on this drawing, a limited amount of sediment removal and displacement occurred outside the depicted dredge limits, on the southern end, and on the northeast corner. Isopach contours in these areas indicate 1 to 2 ft removed and up to 1 ft displaced (i.e., filled by displacement).

Figure 34 shows the top of sediment elevations, measured when pre- and post-dredge cores were taken, at the approximate center of the dredge area subunits. The dredge target elevations are also displayed. The average dredge cut at these locations was 5.8 ft. For the approximate limits of actual dredging depicted on Drawings A10 and A11, covering an area of about 146,000 sf (3.35 acres), this dredge cut computes to 31,400 cy of sediment removed, which is almost identical to the amount calculated from the pre- and post-dredge sediment surveys (31,346 cy). As noted in Section 5.0, we estimated there was 38,670 cy of sediment in the actual dredge area to elevation 565.

Tables 2 and 3 summarize PCB results from the various sample intervals of the pre-dredge and post-dredge cores, respectively. Post-dredge surface PCB concentrations were measured within about two weeks after dredging ended, while the silt curtain still enclosed the Project dredge area. Pre-dredge surface PCB concentrations averaged 4 mg/kg, and the highest measured concentration of all cores in the work area was 650 mg/kg (Subunit 14 at a depth interval of 4 to 5 ft). Figure 35 compares the PCB concentrations in surface samples (0 to 4-in. depth) from the pre- and post-dredge cores, in addition to the maximum PCB concentration detected at each pre-dredge core. As shown, the post-dredge surface PCB concentrations were considerably higher than the pre-dredge surface concentrations where the clean-up dredge pass was not performed, except at one core location (Subunit 38). However, the post-dredge concentrations are less than the maximum PCB concentrations measured in the pre-dredge cores. This is not unexpected, because dredging was incomplete in most areas (i.e., dredging did not reach target elevations).

Figure 36 focuses on the four subunits (25 through 28) where a clean-up dredge pass was performed in a small area prior to discontinuing work. At three of these four locations, the post-dredge surface PCB concentrations (ranging from no detection to 2.0 mg/kg) were below the pre-dredge concentrations. At the fourth location (Subunit 28), the post-dredge surface PCB concentration was 4.5 to 17 mg/kg compared to the pre-dredge concentration of 2.7 mg/kg.

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6.0 COSTS

A summary of Project costs are shown in Table 4, from investigation and pre-design, through procurement and permitting, and construction and monitoring. A more detailed breakout of Project costs is contained in Table B-1 of Appendix B. The basis of the costs is described in the notes at the bottom of the tables.

The total cost for this Demonstration Project was just under $12.4 million. Investigation, pre-design, procurement, and permitting cost just under $0.9 million. Construction and monitoring costs totaled approximately $11.5 million, or $366/cy of sediment dredged. The $11.5 million includes a value of about $3.4 million calculated by Fort James for their in-kind services on the Project, or $108/cy. In-kind services by Fort James included use of the Shell property at no direct project cost, and the estimated additional costs if transportation and disposal of the dewatered sediments to an out-of-state TCSA landfill had been necessary. Other in-kind services were the costs of Fort James' employee time on the Project, technical consultants to Fort James, and Project signage.

Costs for operational monitoring and environmental monitoring (by others) were approximately $2.3 million of the $11.5 million, or $72/cy. Project insurance costs were just under $0.25 million, or about $8/cy. The net costs for site preparation, dredging, dewatering, water treatment, transportation and disposal of the sediments, and construction management, were then approximately $5.6 million, or $178/cy. Potential future dredging projects on the Fox River would likely have lower monitoring costs than the SMU 56/57 Demonstration Project, given the lessons learned from this and the other Demonstration Project at Deposit N. However, transportation and disposal costs ($68/cy) would likely be higher than this Demonstration Project, because of the subsidies provided by Fort James and the nearness of their disposal facility to the Project site.

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7.0 SUMMARY AND CONCLUSIONS

A Sediment Removal Demonstration Project was conducted at Sediment Management Unit 56/57 (SMU 56/57) on the lower Fox River in Green Bay, Wisconsin. Objectives of the Project were to:

- Evaluate potential impacts to the Fox River from large-scale dredging of PCB-contaminated sediments,

- Evaluate the efficacy of large-scale dewatering and land disposal of PCB-contaminated sediments, and

- Evaluate the potential costs of large-scale dredging, dewatering, and land disposal of PCB-contaminated sediments.

The Project was conducted by the Wisconsin Department of Natural Resources (WDNR) and the Fox River Group of Companies (FRG) beginning in September 1997. The general contractor for the design and implementation of the Project was Montgomery Watson. Investigation and design activities were completed between September 1997 and May 1998. Procurement and permitting activities were performed between June 1998 and June 1999. Site improvements for the Project began in July 1999 and dredging began in late August 1999. Dredging ended in December 1999. Demobilization and site restoration were completed in July 2001.

The objectives of the SMU 56/57 Project were met despite the fact that the volume of sediment dredged was less than anticipated. Production goals were not achieved, and budget constraints and winter weather forced halting of the Project. Project metrics include:

- A total of 31,346 cy of sediment were removed from the river, at a total construction cost of about $11.5 million or $366/cy. Subtracting out costs for monitoring, insurance, and the value of in-kind services, the net costs for site preparation, dredging, dewatering, water treatment, transportation and disposal of the sediment, and construction management totaled about $178/cy.

- A total of 1,441 lb of PCBs were removed from the river, at a total construction cost of just under $8,000/lb.

- A total of 30.3 lb of mercury were removed from the river.

- The average hourly dredge rate was 60 cy/hr compared to a goal of 200 cy/hr.

- The average daily dredge rate was 294 cy/day compared to a goal of 900 cy/day. The highest average dredge rate was 473 cy/day.

- The computed average percent solids in the dredge slurry was 4.4% compared to a goal of 7.5%.

- A total of 31,792 wet tons of sediment and other Project materials (13,707 dry tons of sediment only) were disposed of in Cell 12A at the Fort James Corporation industrial landfill in Green Bay. These materials were transported in 1,489 truck loads. According to Fort James, the Demonstration Project used 27,600 cy of air space in their landfill (i.e., wet bulk density of 85 lb/cf).

- The percent solids averaged 53.1% for sediments dewatered in the filter presses compared to a goal of 58%.

- A total of 75,256,500 gal of water from the dredging and dewatering operations were treated and discharged to the river at an estimated cost of $0.013/gal, excluding monitoring costs.

- Turbidity changes measured at the silt curtain upstream, downstream, and sidestream of the operating dredge were low, generally less than 10 to 15 NTUs. Changes in turbidity were more evident right at the dredge, but the amounts were variable.

- Surface PCB concentrations in post-dredge samples (range of non-detectable to 2.0 mg/kg) were less than pre-dredge concentrations (2.3 to 3.3 mg/kg) in three of the four locations where a dredge clean-up pass was performed. In the fourth location where a clean-up pass was performed, the post-dredge PCB concentrations (4.5 to 17 mg/kg) were elevated compared to the measured pre-dredge concentration (2.7 mg/kg). In areas where the clean-up pass was not performed, surface PCB concentrations were higher, as expected, because the dredging was incomplete in these areas (i.e., dredging did not reach target elevations). Note that post-dredge surface PCB concentrations were measured within about two weeks after dredging ended, while the silt curtain still enclosed the Project dredge area.

The Sediment Removal Demonstration Project showed that <u>mass removal</u> of PCBs from contaminated sediments can be accomplished with hydraulic dredging, mechanical dewatering, and landfilling. However, the Demonstration Project also showed that incomplete dredging can result in higher surficial concentrations of PCBs than pre-dredging values. In addition, while the individual process units of hydraulic dredging, mechanical dewatering, and water treatment are well understood, a continuous process train of these three processes proved to be more complicated than anticipated, and costs for removal were higher than expected.

7.1 DREDGING

The hydraulic dredges used for the Demonstration Project were not able to provide the target production of 200 cy/hr. Three different dredges were used: one with a 12-in. pump and round cutterhead, and two dredges with a horizontal auger cutterhead (10-in. and 12-in. pump). Different combinations of on-shore booster pumps were also used. The dredge used for most of the Project had a 12-in. pump and 9-ft wide horizontal auger cutterhead. Several factors may have limited production. A similar dredge with a larger dredge pump and/or on-shore booster pump (i.e., more total system horsepower), or a different type of dredge (e.g., a swinging ladder dredge), may have provided the desired production, but time and financial constraints prevented trials with other dredge systems. The experience level of different dredge operators varied over the course of the Project, which in all likelihood also affected dredge production.

The lower dredge production impacted the process train by requiring more dredge hours per day, which lessened the settling time available in the equalization basins. More significantly, the computed percent solids pumped with the dredge averaged about 4.4% compared to the target of 7.5%. This had an impact on the rest of the process train. It had the cascading effect of lowering sediment removal rates, increasing the duration of the Project, increasing the volume of water to be treated, and increasing the amount of time for dewatering, as well as the amount of lime for processing of the sediments. The increased lime usage escalated the usage of acid to buffer the increased pH of the press filtrate water. Lower percent solids in the dredge slurry meant that the amount of water being pumped was considerably more than anticipated. The combination of these effects had a significant impact on the cost of treatment.

The Demonstration Project showed the importance of the of the dredge percent solids to the rest of the treatment train. Factors that may have affected the percent solids include difficulties in precise dredge positioning, the overall horsepower of the dredging system, dredge operator experience with these specific Project and river conditions, and the density of the river sediments. In a larger-scale sediment removal project, the process train may need to be oversized to account for these factors. The Demonstration Project showed that it may also be valuable to evaluate several different dredge types to see if greater percent solids can be achieved.

Potential ramping up to even larger-scale sediment removal projects in the future utilizing hydraulic dredging and mechanical dewatering will limit the number of environmental dredging and dewatering contractors with proven experience at these removal scales. Most large dredging contractors in the United States have little or no experience with contaminated sediment projects, working predominantly on navigational dredging projects. Navigational dredging projects typically have no environmental controls, resulting in higher production rates and lower unit costs. Larger-scale projects may also limit the available temporary water treatment and dewatering equipment unless planned well in advance, as well as on-shore land space, that are necessary to complete the work in a timely fashion.

An important finding of the Demonstration Project was that cable anchorage of the horizontal auger cutterhead dredge lead to difficulties with controlling the dredge position for multiple passes on the same cut and on adjacent cuts, leaving undredged sediments behind. The necessity to make additional passes to remove ridges or to meet target elevations resulted in inefficient passes that generated significant additional quantities of water requiring treatment. While use of shorter cables and positioning systems may provide tighter control, it should be anticipated that this would be a significant problem in large-scale dredging in an open river environment.

The difficulties in achieving target elevations suggest another potential problem in large-scale dredging. One clean-up pass may not be sufficient to meet target parameters. The need for additional passes would significantly increase costs because these passes are inefficient and generate large quantities of water.

Other findings of the Demonstration Project were:

- The unit cost for the dredging component of this Demonstration Project was about $14/cy of sediment removed. This unit cost excludes additional dredging costs that were not approved because the dredge production goals were not achieved. Records were not kept to differentiate the unit costs of production dredging compared to clean-up pass dredging.

- Debris was encountered during dredging, which to a degree hindered dredging progress. However, the amount and type of debris encountered were neither excessive nor unexpected for this river environment and Project location.

- The silt curtain portion of the total dredging cost for this Demonstration Project was about $67/lineal ft of curtain. Differences between turbidity measurements inside and outside the silt curtain were not that significant. This naturally leads one to question whether a silt curtain would be cost effective and necessary on future dredging projects. The results of water column testing from the environmental monitoring studies by others should be used to address this question.

- The silt curtain anchorage system installed in the soft river sediments was marginally adequate to keep the curtain secured around the dredge area. Future dredging projects should consider use of other types of anchors (e.g., piling, larger concrete deadmen) at spacing sufficient to secure the curtain against lateral forces from the river current, wave action, coal boat prop wash, and wind.

- A silt curtain must be inspected frequently to ensure integrity. The batteries in lights for night-time illumination require frequent maintenance.

- Slurry sampling from the dredge pipeline proved to be difficult. Different methods for slurry flow monitoring should be considered.

- Dredging can accommodate commercial boat traffic, but it is disruptive to production. This would likely affect costs on potential future projects that involved commercial boat traffic.

7.2 WATER TREATMENT

The estimated water treatment costs for this Demonstration Project totaled $31/cy of sediment removed from the river, or $0.013/gal treated. This unit cost excludes additional water treatment costs that were not approved because the dredge production goals were not achieved. Using the average PCB concentration of 4.8 ug/L in the treatment system influent from the equalization basins, and the 75,256,500 gal of water treated, water treatment cost about $327,000/lb of PCBs prevented from being returned back to the river.

The water treatment system was effective in meeting the PCB discharge concentration limit of 1.2 ug/L established by the Project WPDES Permit. The PCB discharge mass limit of 0.0072 lb/day was also met. An important finding of an evaluation of the treatment steps was that tertiary treatment with granular activated carbon was necessary to comply with the PCB concentration limit; primary and secondary treatment through settling and filtration were insufficient. Based on detection of PCBs in only one effluent sample at a concentration well below the discharge limit, an estimated 0.028 lb of PCBs were returned to the river in the treated water. About 3 lb of PCBs were prevented from being discharged compared to about 0.028 lb that were discharged, for a 99.1% removal efficiency.

The daily maximum discharge concentration limit of 1.7 ug/L for mercury was also met by the treatment system. However, the monthly mass limit of 0.000034 lb/day was exceeded, as reported in the monthly discharge monitoring reports to the WDNR. Based on the sample concentrations and flows, an estimated 0.0076 lb of mercury were returned to the river over the course of the Project. For potential future sediment removal projects, consideration could be given to removing the mercury mass limit from project WPDES Permits, because of the high volumes of water to be treated and the high costs already associated with tertiary water treatment. Alternatively, additional filtration may successfully lower the mercury concentrations.

Several exceedances of the 10-mg/L daily maximum discharge limit for total suspended solids were measured in the first few weeks of the Demonstration Project. This problem was corrected by relocating the diversion piping used during back-washing of the filter and carbon vessels to a point upstream of the effluent sampler, which eliminated mixing with the treated effluent samples.

BOD_5 (limit of <2mg/L) could not be controlled by the treatment system used on this Project. A biological treatment process may be required on potential future projects unless the BOD_5 limit can be raised or eliminated. Credits may also be available from other industrial dischargers on the Fox River who are well under their respective BOD_5 limits.

Controlling effluent pH was complicated by the addition of lime to the dredge slurry to aid in mechanical dewatering by filter pressing. The resulting pH of the press filtrate water was elevated, and required acid addition to buffer the pH into the WPDES Permit range of 6 to 9. Initially, the press filtrate water and basin supernatant water were processed together through the treatment system, and these water sources varied in volume, pH, and turbidity. After the filtrate and basin supernatant water treatment systems were separated, pH and turbidity control were much simpler. Consideration should be given to separating water sources for treatment on future projects, and/or using additives other than lime to aid in mechanical dewatering of the sediment slurry (e.g., polymers).

No dioxins (2,3,7,8-TCDD) were measured in the effluent samples at the laboratory detection limits. All oil and grease results were below the WPDES Permit limit of 10 mg/L. Ammonia nitrogen was monitored, but the WPDES Permit did not establish a discharge limit for this parameter.

Overall, the Project successfully met Permit limits without significant exceedances. The water treatment system was readily adjusted to quickly correct temporary exceedances.

7.3 DEWATERING

The dewatering component of this Demonstration Project cost $30/cy of sediment removed from the river, almost as much as the water treatment component.

Dewatered sediment with as low as 47% solids passed paint filter testing, to be classified as solid waste for disposal. However, at this percent solids the material was very wet and difficult to manage at the landfill. Dewatering to an average 53% solids provided material that could suitably be managed.

About one-third of the dewatered sediments (mass) disposed at the landfill had PCB concentrations greater than the 50 mg/kg TSCA limit. In other areas of the river where sediments are likely to have lower PCB concentrations, most of the sediment may able to be managed and disposed as non-TSCA material based on PCB concentrations after dewatering. This would potentially expand the number of landfills available for sediment disposal, and could save on disposal costs compared to in-state or out-of-state TSCA landfills.

Although protective provisions were made in the equipment used to pump the dredged slurry from the equalization basins to the filter presses for dewatering, the geomembrane component of the basin liners was still damaged. This caused reduced production during repairs. On potential future sediment removal projects where mechanical dewatering will be used, consideration should be given to different methods of solids removal from equalization basins (if used) to protect the liner, eliminating the membrane liner and possibly thickening the clay liner component, or replacing earthen basins with steel tanks.

The recessed chamber filter presses used for dewatering proved to be highly sensitive to low feed slurry concentrations. For potential future hydraulic dredging and mechanical dewatering projects, consideration should be given to using polymers instead of lime for feed stabilization prior to dewatering in recessed chamber filter presses. Other dewatering technologies could also be considered, which could be less sensitive to slurry concentrations and reduce the water treatment impacts (e.g., belt thickener before a recessed chamber filter press, belt filter press, or centrifuge).

7.4 TRANSPORTATION AND DISPOSAL

Transportation and disposal costs at an estimated $68/cy of sediment removed from the river were the most costly component of this Demonstration Project. However, transportation and disposal costs were partially subsidized by Fort James Corporation through use of their landfill and other in-kind services. Based on quotes received before Fort James' landfill was approved, T&D costs would have been on the order of $100 to $150/cy of dewatered sediment for an out-of-state commercial TSCA landfill. The unit cost for non-TSCA disposal would very likely be less than the cost for TSCA disposal, but how much less would be dependent on several factors, including landfill distance from the project site, disposal volume, and market forces.

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TABLES

TABLE 1
FINAL PROJECT METRICS
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Item	1999 Demonstration Project	2000 Demobilization Work	Project Totals
In-River Dredge Volume	31,346 cubic yards	---	31,346 cubic yards
Wet Mass of Materials Landfilled			
Dewatered Sediment with Lime	26,838 wet tons	3,893 wet tons	30,731 wet tons
Water Treatment Filter Media	89 wet tons	18 wet tons	107 wet tons
Other Project Wastes	0 wet tons	954 wet tons	954 wet tons
Total Mass Landfilled	26,927 wet tons	4,865 wet tons	31,792 wet tons
Number of Truck Loads to Landfill	1,240	249	1,489
Dry Mass of Sediment Only			
Dewatered Sediment with Lime	14,294 dry tons	2,344 dry tons	16,638 dry tons
Added Lime	2,598 dry tons	333 dry tons	2,931 dry tons
Total Sediment Only	11,696 dry tons	2,011 dry tons	13,707 dry tons
Mass of PCBs Removed			
Dewatered Sediment with Lime	1,326 pounds	111 pounds	1,437 pounds
Water Treatment Filter Media	1 pound	---	1 pound
Other Project Wastes	---	3 pounds	3 pounds
Total PCBs Removed	1,327 pounds	114 pounds	1,441 pounds
Mass of Mercury Removed			
Dewatered Sediment with Lime	27.8 pounds	2.4 pounds	30.2 pounds
Water Treatment Filter Media	---	---	---
Other Project Wastes	---	0.1 pound	0.1 pound
Total Mercury Removed	27.8 pounds	2.5 pounds	30.3 pounds
Volume of Water Treated	75,256,500 gallons	957,400 gallons	76,213,900 gallons

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU120004	08/19/99	2,600	0.0	575.0	575.0
SU120412	08/19/99	190,000	0.3	575.0	574.7
SU120102	08/19/99	300,000	1.0	575.0	574.0
SU120203	08/19/99	200,000	2.0	575.0	573.0
SU120304	08/19/99	130,000	3.0	575.0	572.0
SU120405	08/19/99	19,000	4.0	575.0	571.0
SU120506	08/19/99	6,100	5.0	575.0	570.0
SU120607	08/19/99	1,700	6.0	575.0	569.0
SU120708	08/19/99	780	7.0	575.0	568.0
SU120809	08/19/99	420	8.0	575.0	567.0
SU120910	08/19/99	380	9.0	575.0	566.0
SU121011	08/19/99	59	10.0	575.0	565.0
SU121112	08/19/99	66	11.0	575.0	564.0
SU121213	08/19/99	32	12.0	575.0	563.0
SU121314	08/19/99	40	13.0	575.0	562.0
SU121415	08/19/99	43	14.0	575.0	561.0
SU130004	08/19/99	5,300	0.0	574.9	574.9
SU130412	08/19/99	100,000	0.3	574.9	574.6
SU130102	08/19/99	110,000	1.0	574.9	573.9
SU130203	08/19/99	300,000	2.0	574.9	572.9
SU130304	08/19/99	440,000	3.0	574.9	571.9
SU130405	08/19/99	630,000	4.0	574.9	570.9
SU130506	08/19/99	390,000	5.0	574.9	569.9
SU130506 DUPLICATE	08/19/99	550,000	5.0	574.9	569.9
SU130607	08/19/99	9,800	6.0	574.9	568.9
SU130708	08/19/99	3,500	7.0	574.9	567.9
SU130809	08/19/99	680	8.0	574.9	566.9
SU130910	08/19/99	200	9.0	574.9	565.9
SU131011	08/19/99	0	10.0	574.9	564.9
SU131112	08/19/99	0	11.0	574.9	563.9
SU140004	08/19/99	3,500	0.0	574.3	574.3
SU140412	08/19/99	110,000	0.3	574.3	574.0
SU140102	08/19/99	15,000	1.0	574.3	573.3
SU140203	08/19/99	180,000	2.0	574.3	572.3
SU140304	08/19/99	340,000	3.0	574.3	571.3

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU140405	08/19/99	650,000	4.0	574.3	570.3
SU140506	08/19/99	310,000	5.0	574.3	569.3
SU140607	08/19/99	360,000	6.0	574.3	568.3
SU140708	08/19/99	150,000	7.0	574.3	567.3
SU140809	08/19/99	5,000	8.0	574.3	566.3
SU140910	08/19/99	1,500	9.0	574.3	565.3
SU141011	08/19/99	440	10.0	574.3	564.3
SU141112	08/19/99	130	11.0	574.3	563.3
SU141213	08/19/99	480	12.0	574.3	562.3
SU150004	08/20/99	2,200	0.0	574.3	574.3
SU150412	08/20/99	3,100	0.3	574.3	574.0
SU150102	08/20/99	6,100	1.0	574.3	573.3
SU150203	08/20/99	24,000	2.0	574.3	572.3
SU150304	08/20/99	400,000	3.0	574.3	571.3
SU150405	08/20/99	400,000	4.0	574.3	570.3
SU150506	08/20/99	450,000	5.0	574.3	569.3
SU150607	08/20/99	540,000	6.0	574.3	568.3
SU150708	08/20/99	22,000	7.0	574.3	567.3
SU150809	08/20/99	1,800	8.0	574.3	566.3
SU150910	08/20/99	1,600	9.0	574.3	565.3
SU151011	08/20/99	2,900	10.0	574.3	564.3
SU15D0004	08/20/99	390	0.0	574.3	574.3
SU15D0412	08/20/99	5,100	0.3	574.3	574.0
SU15D0102	08/20/99	9,600	1.0	574.3	573.3
SU15D0203	08/20/99	36,000	2.0	574.3	572.3
SU15D0304	08/20/99	170,000	3.0	574.3	571.3
SU15D0405	08/20/99	360,000	4.0	574.3	570.3
SU15D0506	08/20/99	490,000	5.0	574.3	569.3
SU15D0607	08/20/99	350,000	6.0	574.3	568.3
SU15D0708	08/20/99	67,000	7.0	574.3	567.3
SU15D0809	08/20/99	2,100	8.0	574.3	566.3
SU15D0910	08/20/99	2,400	9.0	574.3	565.3
SU15D1011	08/20/99	170	10.0	574.3	564.3

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU160004	08/19/99	3,800	0.0	573.1	573.1
SU160412	08/19/99	6,800	0.3	573.1	572.8
SU160102	08/19/99	11,000	1.0	573.1	572.1
SU160203	08/19/99	27,000	2.0	573.1	571.1
SU160304	08/19/99	150,000	3.0	573.1	570.1
SU160405	08/19/99	310,000	4.0	573.1	569.1
SU160506	08/19/99	290,000	5.0	573.1	568.1
SU160607	08/19/99	71,000	6.0	573.1	567.1
SU160708	08/19/99	94,000	7.0	573.1	566.1
SU160708 DUPLICATE	08/19/99	78,000	7.0	573.1	566.1
SU160809	08/19/99	66,000	8.0	573.1	565.1
SU160910	08/19/99	960	9.0	573.1	564.1
SU170004	08/19/99	5,300	0.0	574.1	574.1
SU170412	08/19/99	12,000	0.3	574.1	573.8
SU170102	08/19/99	20,000	1.0	574.1	573.1
SU170203	08/19/99	67,000	2.0	574.1	572.1
SU170304	08/19/99	350,000	3.0	574.1	571.1
SU170405	08/19/99	280,000	4.0	574.1	570.1
SU170506	08/19/99	3,300	5.0	574.1	569.1
SU170607	08/19/99	1,200	6.0	574.1	568.1
SU170708	08/19/99	1,400	7.0	574.1	567.1
SU170809	08/19/99	850	8.0	574.1	566.1
SU170910	08/19/99	370	9.0	574.1	565.1
SU171011	08/19/99	170	10.0	574.1	564.1
SU171112	08/19/99	49	11.0	574.1	563.1
SU230004	08/18/99	2,800	0.0	573.5	573.5
SU230412	08/18/99	8,700	0.3	573.5	573.2
SU230102	08/18/99	350,000	1.0	573.5	572.5
SU230203	08/18/99	230,000	2.0	573.5	571.5
SU230304	08/18/99	140,000	3.0	573.5	570.5
SU230405	08/18/99	8,100	4.0	573.5	569.5
SU230506	08/18/99	3,500	5.0	573.5	568.5
SU230607	08/18/99	1,300	6.0	573.5	567.5
SU230708	08/18/99	310	7.0	573.5	566.5
SU230809	08/18/99	350	8.0	573.5	565.5

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU230910	08/18/99	95	9.0	573.5	564.5
SU231011	08/18/99	65	10.0	573.5	563.5
SU240004	08/18/99	3,200	0.0	573.5	573.5
SU240412	08/18/99	22,000	0.3	573.5	573.2
SU240102	08/18/99	130,000	1.0	573.5	572.5
SU240203	08/18/99	270,000	2.0	573.5	571.5
SU240304	08/18/99	80,000	3.0	573.5	570.5
SU240405	08/18/99	9,200	4.0	573.5	569.5
SU240506	08/18/99	1,300	5.0	573.5	568.5
SU240607	08/18/99	490	6.0	573.5	567.5
SU240708	08/18/99	290	7.0	573.5	566.5
SU240809	08/18/99	52	8.0	573.5	565.5
SU240910	08/18/99	67	9.0	573.5	564.5
SU240910 DUPLICATE	08/18/99	78	9.0	573.5	564.5
SU24D0004	08/18/99	2,400	0.0	573.5	573.5
SU24D0412	08/18/99	8,900	0.3	573.5	573.2
SU24D0102	08/18/99	230,000	1.0	573.5	572.5
SU24D0203	08/18/99	250,000	2.0	573.5	571.5
SU24D0304	08/18/99	130,000	3.0	573.5	570.5
SU24D0405	08/18/99	9,600	4.0	573.5	569.5
SU24D0506	08/18/99	1,200	5.0	573.5	568.5
SU24D0607	08/18/99	260	6.0	573.5	567.5
SU24D0708	08/18/99	160	7.0	573.5	566.5
SU24D0809	08/18/99	120	8.0	573.5	565.5
SU250004	08/18/99	3,100	0.0	573.0	573.0
SU250412	08/18/99	5,500	0.3	573.0	572.7
SU250102	08/18/99	94,000	1.0	573.0	572.0
SU250203	08/18/99	330,000	2.0	573.0	571.0
SU250304	08/18/99	290,000	3.0	573.0	570.0
SU250405	08/18/99	3,600	4.0	573.0	569.0
SU250506	08/18/99	1,700	5.0	573.0	568.0
SU250607	08/18/99	430	6.0	573.0	567.0
SU250708	08/18/99	460	7.0	573.0	566.0
SU250809	08/18/99	46	8.0	573.0	565.0
SU250910	08/18/99	39	9.0	573.0	564.0

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU251011	08/18/99	0	10.0	573.0	563.0
SU260004	08/17/99	2,300	0.0	572.5	572.5
SU260412	08/17/99	7,800	0.3	572.5	572.2
SU260102	08/17/99	200,000	1.0	572.5	571.5
SU260203	08/17/99	250,000	2.0	572.5	570.5
SU260304	08/17/99	18,000	3.0	572.5	569.5
SU260405	08/17/99	2,200	4.0	572.5	568.5
SU260506	08/17/99	2,200	5.0	572.5	567.5
SU260607	08/17/99	350	6.0	572.5	566.5
SU260607 DUPLICATE	08/17/99	460	6.0	572.5	566.5
SU260708	08/17/99	230	7.0	572.5	565.5
SU260809	08/17/99	110	8.0	572.5	564.5
SU260910	08/17/99	42	9.0	572.5	563.5
SU261011	08/17/99	28	10.0	572.5	562.5
SU261112	08/17/99	28	11.0	572.5	561.5
SU261213	08/17/99	26	12.0	572.5	560.5
SU261314	08/17/99	95	13.0	572.5	559.5
SU270004	08/17/99	3,300	0.0	572.3	572.3
SU270412	08/17/99	6,400	0.3	572.3	572.0
SU270102	08/17/99	270,000	1.0	572.3	571.3
SU270203	08/17/99	160,000	2.0	572.3	570.3
SU270304	08/17/99	25,000	3.0	572.3	569.3
SU270405	08/17/99	1,800	4.0	572.3	568.3
SU270506	08/17/99	970	5.0	572.3	567.3
SU270607	08/17/99	790	6.0	572.3	566.3
SU270708	08/17/99	270	7.0	572.3	565.3
SU270809	08/17/99	110	8.0	572.3	564.3
SU270910	08/17/99	33	9.0	572.3	563.3
SU271011	08/17/99	22	10.0	572.3	562.3
SU280004	08/17/99	2,700	0.0	571.9	571.9
SU280412	08/17/99	7,700	0.3	571.9	571.6
SU280102	08/17/99	86,000	1.0	571.9	570.9
SU280203	08/17/99	220,000	2.0	571.9	569.9
SU280304	08/17/99	3,600	3.0	571.9	568.9
SU280405	08/17/99	3,300	4.0	571.9	567.9

TABLE 2
PRE-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU280506	08/17/99	1,900	5.0	571.9	566.9
SU280607	08/17/99	380	6.0	571.9	565.9
SU280607 DUPLICATE	08/17/99	730	6.0	571.9	565.9
SU280708	08/17/99	250	7.0	571.9	564.9
SU280809	08/17/99	110	8.0	571.9	563.9
SU380004	08/17/99	17,000	0.0	570.0	570.0
SU380412	08/17/99	1,100	0.3	570.0	569.7
SU380102	08/17/99	120	1.0	570.0	569.0
SU380203	08/17/99	77	2.0	570.0	568.0
SU380304	08/17/99	71	3.0	570.0	567.0
SU380405	08/17/99	81	4.0	570.0	566.0
SU380506	08/17/99	56	5.0	570.0	565.0
SU380607	08/17/99	27	6.0	570.0	564.0
SU380607 DUPLICATE	08/17/99	33	6.0	570.0	564.0
SU380708	08/17/99	36	7.0	570.0	563.0
SU380809	08/17/99	26	8.0	570.0	562.0

Notes:
1) Field Sample ID nomenclature - Examples SU120004, SU120412, and SU120607
   SU12 = Core sample in the center of Subunit 12
   0004 = Sample interval from 0 to 4 inches below top of sediment
   0412 = Sample interval from 4 to 12 inches below top of sediment
   0607 = Sample interval from 6 to 7 feet below top of sediment
2) Elevation referenced to Mean Sea Level, NGVD29

TABLE 3
POST-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU120004PD	01/07/00	37,000	0.0	569.3	569.3
SU1200412PD	01/07/00	60,000	0.3	569.3	569.0
SU120102PD	01/07/00	52,000	1.0	569.3	568.3
SU120102PD-DP	01/07/00	51,000	1.0	569.3	568.3
SU120203PD	01/07/00	260	2.0	569.3	567.3
SU120304PD	01/07/00	12	3.0	569.3	566.3
SU130004PD	01/07/00	220,000	0.0	569.2	569.2
SU1300412PD	01/07/00	190,000	0.3	569.2	568.9
SU130102PD	01/07/00	13,000	1.0	569.2	568.2
SU130203PD	01/07/00	21	2.0	569.2	567.2
SU140004PD	12/28/99	280,000	0.0	568.8	568.8
SU1400412PD	12/28/99	330,000	0.3	568.8	568.5
SU140102PD	12/28/99	79,000	1.0	568.8	567.8
SU140203PD	12/28/99	120	2.0	568.8	566.8
SU150004PD	12/21/99	160,000	0.0	567.4	567.4
SU1500412PD	12/21/99	34,000	0.3	567.4	567.1
SU150102PD	12/21/99	1,500	1.0	567.4	566.4
SU150203PD	12/21/99	91	2.0	567.4	565.4
SU160004PD	12/28/99	41,000	0.0	566.0	566.0
SU1600412PD	12/28/99	30,000	0.3	566.0	565.7
SU160102PD	12/28/99	14,000	1.0	566.0	565.0
SU160203PD	12/28/99	320	2.0	566.0	564.0
SU160304PD	12/28/99	23	3.0	566.0	563.0
SU160304PD DUP	12/28/99	31	3.0	566.0	563.0
SU170004PD	12/28/99	32,000	0.0	565.8	565.8
SU1700412PD	12/28/99	35,000	0.3	565.8	565.5
SU170102PD	12/28/99	5,300	1.0	565.8	564.8
SU170203PD	12/28/99	0	2.0	565.8	563.8
SU230004PD	01/07/00	120,000	0.0	572.2	572.2
SU2300412PD	01/07/00	180,000	0.3	572.2	571.9
SU230102PD	01/07/00	79,000	1.0	572.2	571.2
SU230203PD	01/07/00	27,000	2.0	572.2	570.2
SU230304PD	01/07/00	36	3.0	572.2	569.2
SU230405PD	01/07/00	21	4.0	572.2	568.2

TABLE 3
POST-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU240004PD	12/28/99	49,000	0.0	568.4	568.4
SU2400412PD	12/28/99	25,000	0.3	568.4	568.1
SU2400412PD DUP	12/28/99	33,000	0.3	568.4	568.1
SU240102PD	12/28/99	14	1.0	568.4	567.4
SU240203PD	12/28/99	0	2.0	568.4	566.4
SU24D0004PD	12/28/99	41,000	0.0	568.4	568.4
SU24D00412PD	12/28/99	1,100	0.3	568.4	568.1
SU24D0102PD	12/28/99	14	1.0	568.4	567.4
SU24D0203PD	12/28/99	0	2.0	568.4	566.4
SU250004PD	12/27/99	72	0.0	566.9	566.9
SU250004PD DUP	12/27/99	40	0.0	566.9	566.9
SU2500412PD	12/27/99	0	0.3	566.9	566.6
SU250102PD	12/27/99	0	1.0	566.9	565.9
SU25D0004PD	12/27/99	0	0.0	566.9	566.9
SU25D00412PD	12/27/99	0	0.3	566.9	566.6
SU25D0102PD	12/27/99	0	1.0	566.9	565.9
SU260004PD	12/20/99	200	0.0	565.8	565.8
SU2600412PD	12/20/99	12	0.3	565.8	565.5
SU26D0004PD	12/27/99	2,000	0.0	566.3	566.3
SU26D00412PD	12/27/99	22	0.3	566.3	566.0
SU270004PD	12/27/99	1,700	0.0	564.5	564.5
SU2700412PD	12/27/99	3,000	0.3	564.5	564.2
SU27D0004PD	12/27/99	60	0.0	564.5	564.5
SU27D00412PD	12/27/99	0	0.3	564.5	564.2
SU280004PD	12/27/99	4,500	0.0	565.6	565.6
SU2800412PD	12/27/99	100	0.3	565.6	565.3
SU280102PD	12/27/99	0	1.0	565.6	564.6
SU28D0004PD	12/27/99	17,000	0.0	565.6	565.6
SU28D00412PD	12/27/99	1,100	0.3	565.6	565.3
SU28D0102PD	12/27/99	0	1.0	565.6	564.6

TABLE 3
POST-DREDGE SEDIMENT PCBs
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

Field Sample ID	Sample Date	PCBs (ug/kg)	Top of Sample Depth (ft)	Top of Sediment Elevation (MSL)	Top of Sample Elevation (MSL)
SU380004PD	01/07/00	1,000	0.0	566.6	566.6
SU3800412PD	01/07/00	47	0.3	566.6	566.3
SU380102PD	01/07/00	25	1.0	566.6	565.6
SU380102PD-DP	01/07/00	13	1.0	566.6	565.6
SU380203PD	01/07/00	15	2.0	566.6	564.6

Notes:
1) Field Sample ID nomenclature - Examples SU120004PD, SU120102PD-DP
   SU12 = Core sample in the center of Subunit 12
   0004 = Sample interval from 0 to 4 inches below top of sediment
   0102 = Sample interval from 1 to 2 feet below top of sediment
   PD = Post-dredge core
   DP = Duplicate core
2) Elevation referenced to Mean Sea Level, NGVD29

TABLE 4
SUMMARY OF PROJECT COSTS
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

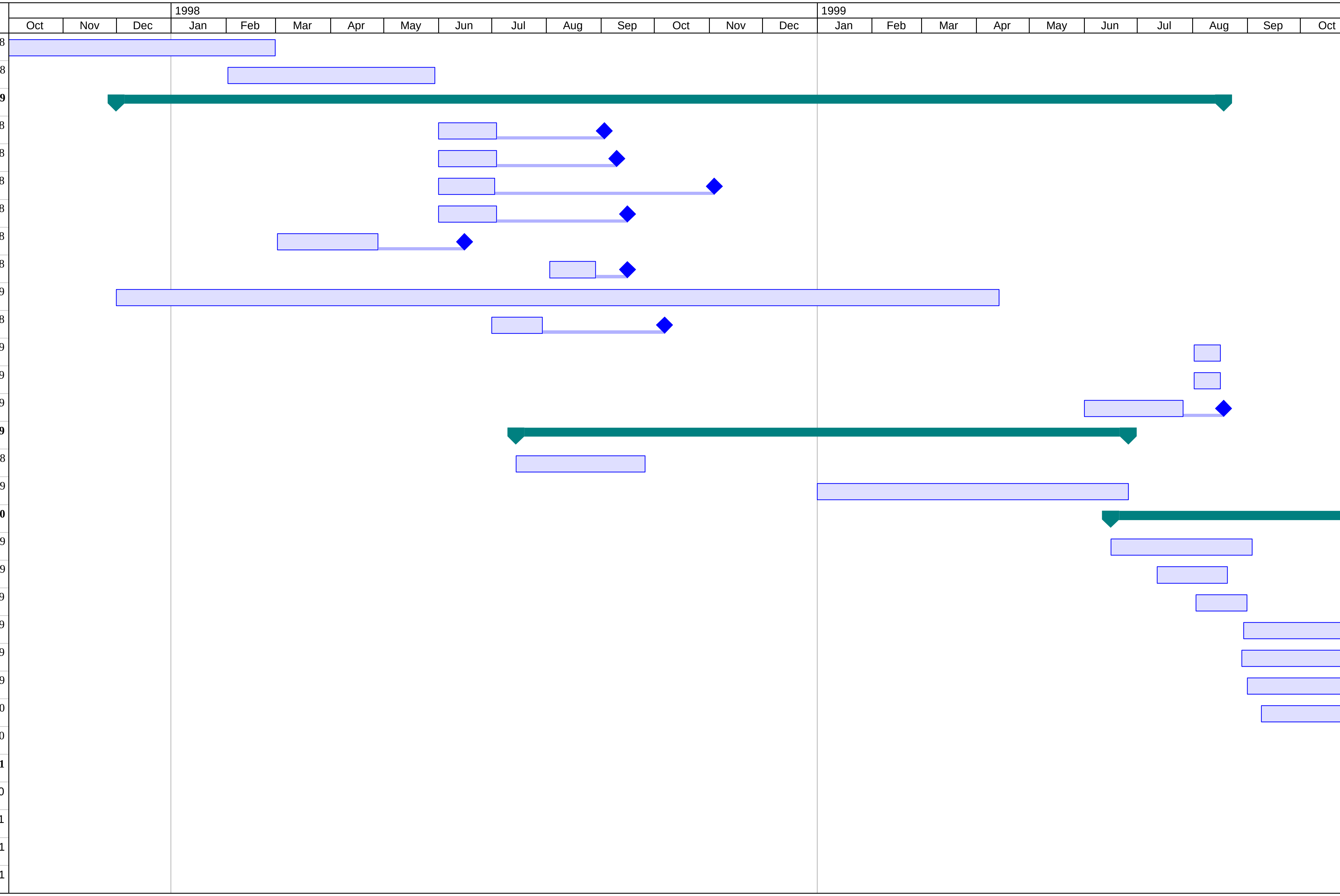
	Item	Cost	Cost Per Cubic Yard Dredged (1)
I	**INVESTIGATION AND PRE-DESIGN**	$566,140	
II	**PROCUREMENT AND PERMITTING**	$328,060	
	PRE-CONSTRUCTION TOTAL	**$894,200**	
III	**CONSTRUCTION AND MONITORING**		
A	Site Improvements & Restoration	$496,730	$16
B	Dredging (2)	$434,750	$14
C	Water Treatment (2)	$985,185	$31
D	Dewatering (2)	$936,650	$30
E1	Operational Monitoring	$1,075,400	$34
E2	Construction Management	$579,500	$18
	Subtotal	$4,508,215	
F	Transportation and Disposal (3)	$2,146,435	$68
G	Project Insurance (4)	$242,515	$8
H	Environmental Monitoring (by others) (4)	$1,180,100	$38
	Subtotal	$3,569,050	
	CONSTRUCTION AND MONITORING TOTAL	**$8,077,265**	$258
	PROJECT TOTAL	**$8,971,465**	
I	Value of Fort James' In-Kind Services (3)	$3,390,100	$108
	CONSTRUCTION AND MONITORING TOTAL w/In-Kind Services	**$11,467,365**	$366
	PROJECT TOTAL w/In-Kind Services	**$12,361,565**	

Notes:
(1) Based on 31,346 cubic yards removed.
(2) Based on payments by the Fox River Group after settlement of a dispute with the primary subcontractor for dredging, water treatment, and dewatering.
(3) Based on reported project costs from Fort James Corporation.
(4) Based on reported project costs from the Fox River Group.

FIGURES

FIGURE 1 - PROJECT TIME LINE
Fox River SMU 56/57

ID	Task Name	Start	Finish
1	**Investigation**	Wed 10/1/97	Sat 2/28/98
2	**Predesign/Basis of Design Report**	Mon 2/2/98	Fri 5/29/98
3	**Permits and Approvals**	**Mon 12/1/97**	**Wed 8/18/99**
4	Environmental Assessment	Mon 6/1/98	Wed 9/2/98
5	WDNR Dredging Permit	Mon 6/1/98	Wed 9/9/98
6	USACE Dredging Permit	Mon 6/1/98	Tue 11/3/98
7	WDNR WPDES Permit	Mon 6/1/98	Tue 9/15/98
8	WDNR Landfill Plan Mod Approval	Mon 3/2/98	Mon 6/15/98
9	WDNR Stormwater Permit	Mon 8/3/98	Tue 9/15/98
10	Fort James Access Agreement	Mon 12/1/97	Tue 4/13/99
11	Green Bay Zoning Approval	Wed 7/1/98	Tue 10/6/98
12	Green Bay Electrical Permit	Mon 8/2/99	Mon 8/16/99
13	Coast Guard Notification	Mon 8/2/99	Mon 8/16/99
14	Operational Monitoring QAPP Approval	Tue 6/1/99	Wed 8/18/99
15	**Procurement**	**Wed 7/15/98**	**Fri 6/25/99**
16	Site Improvements	Wed 7/15/98	Fri 9/25/98
17	Dredging,Dewatering,Water Treatment	Fri 1/1/99	Fri 6/25/99
18	**Construction**	**Wed 6/16/99**	**Mon 7/24/00**
19	Landfill Cell Preparation	Wed 6/16/99	Fri 9/3/99
20	Site Improvements to Shell Property	Mon 7/12/99	Fri 8/20/99
21	Mobilization/Set up	Tue 8/3/99	Tue 8/31/99
22	Dredging	Mon 8/30/99	Wed 12/15/99
23	Dewatering	Sun 8/29/99	Wed 12/15/99
24	Water Treatment	Wed 9/1/99	Sun 12/19/99
25	Transportation/Disposal	Thu 9/9/99	Thu 7/20/00
26	Demobilization	Wed 12/15/99	Mon 7/24/00
27	**Summary Report**	**Thu 1/27/00**	**Fri 9/21/01**
28	Summary Report - First Draft	Thu 1/27/00	Sun 7/9/00
29	Summary Report - Second Draft	Tue 7/11/00	Sun 7/1/01
30	Summary Report - Final	Mon 7/2/01	Fri 9/21/01
31	Submit Final Summary Report	Fri 9/21/01	Fri 9/21/01



Project: Fox River Schedule 1
Date: Thu 9/27/01
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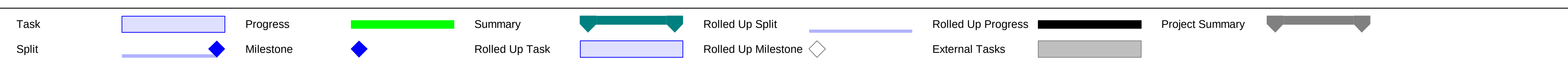

FIGURE 1 - PROJECT TIME LINE
Fox River SMU 56/57

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1	**Investigation**	Wed 10/1/97	Sat 2/28/98
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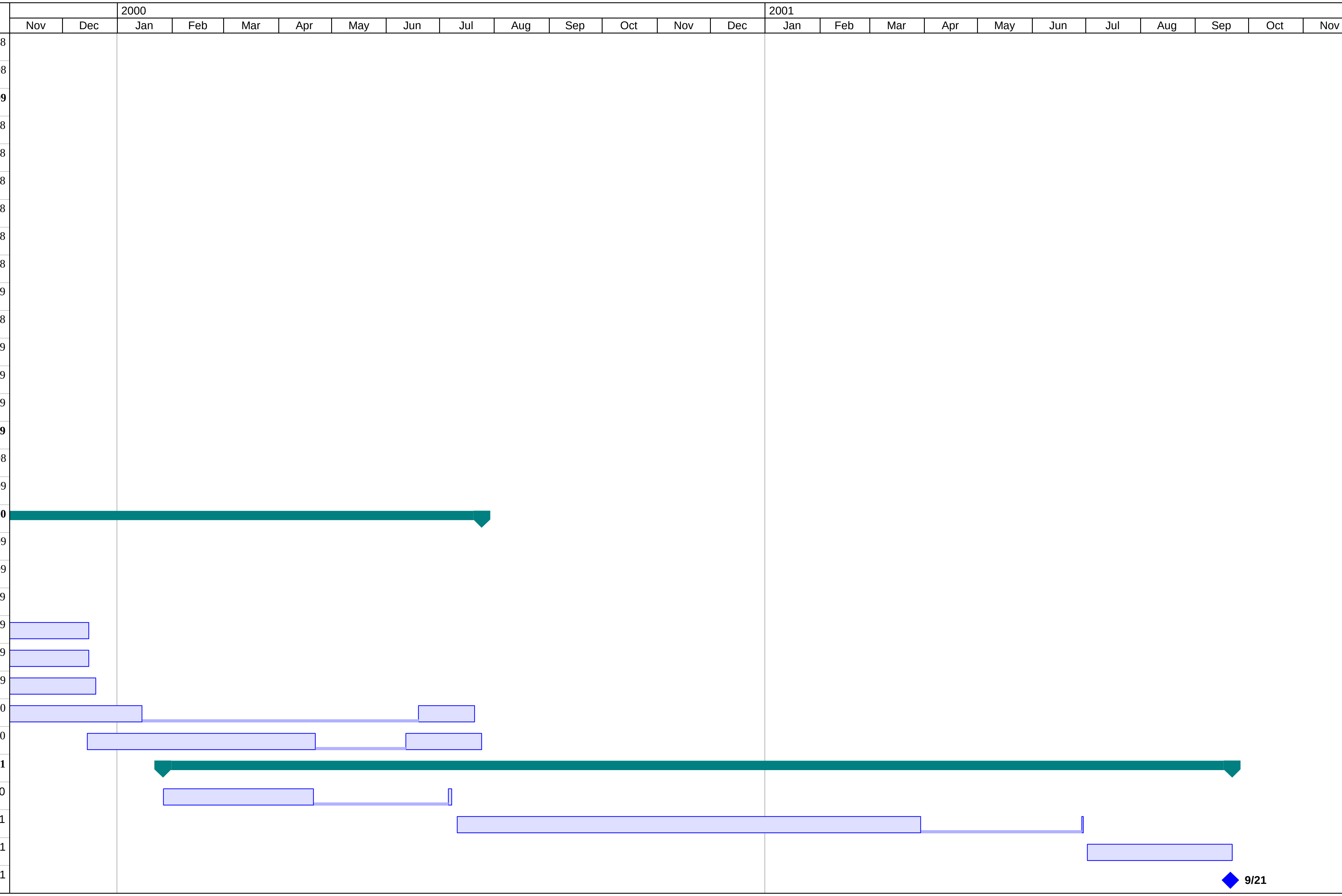
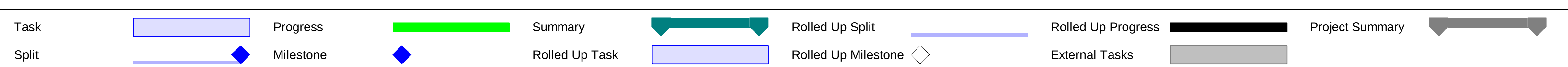
9	WDNR Stormwater Permit	Mon 8/3/98	Tue 9/15/98
10	Fort James Access Agreement	Mon 12/1/97	Tue 4/13/99
11	Green Bay Zoning Approval	Wed 7/1/98	Tue 10/6/98
12	Green Bay Electrical Permit	Mon 8/2/99	Mon 8/16/99
13	Coast Guard Notification	Mon 8/2/99	Mon 8/16/99
14	Operational Monitoring QAPP Approval	Tue 6/1/99	Wed 8/18/99
15	**Procurement**	**Wed 7/15/98**	**Fri 6/25/99**
16	Site Improvements	Wed 7/15/98	Fri 9/25/98
17	Dredging,Dewatering,Water Treatment	Fri 1/1/99	Fri 6/25/99
18	**Construction**	**Wed 6/16/99**	**Mon 7/24/00**
19	Landfill Cell Preparation	Wed 6/16/99	Fri 9/3/99
20	Site Improvements to Shell Property	Mon 7/12/99	Fri 8/20/99
21	Mobilization/Set up	Tue 8/3/99	Tue 8/31/99
22	Dredging	Mon 8/30/99	Wed 12/15/99
23	Dewatering	Sun 8/29/99	Wed 12/15/99
24	Water Treatment	Wed 9/1/99	Sun 12/19/99
25	Transportation/Disposal	Thu 9/9/99	Thu 7/20/00
26	Demobilization	Wed 12/15/99	Mon 7/24/00
27	**Summary Report**	**Thu 1/27/00**	**Fri 9/21/01**
28	Summary Report - First Draft	Thu 1/27/00	Sun 7/9/00
29	Summary Report - Second Draft	Tue 7/11/00	Sun 7/1/01
30	Summary Report - Final	Mon 7/2/01	Fri 9/21/01
31	Submit Final Summary Report	Fri 9/21/01	Fri 9/21/01



Project: Fox River Schedule 1
Date: Thu 9/27/01
2082057.01470101



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LAB/RHW

FIGURE 1 - PROJECT TIME LINE

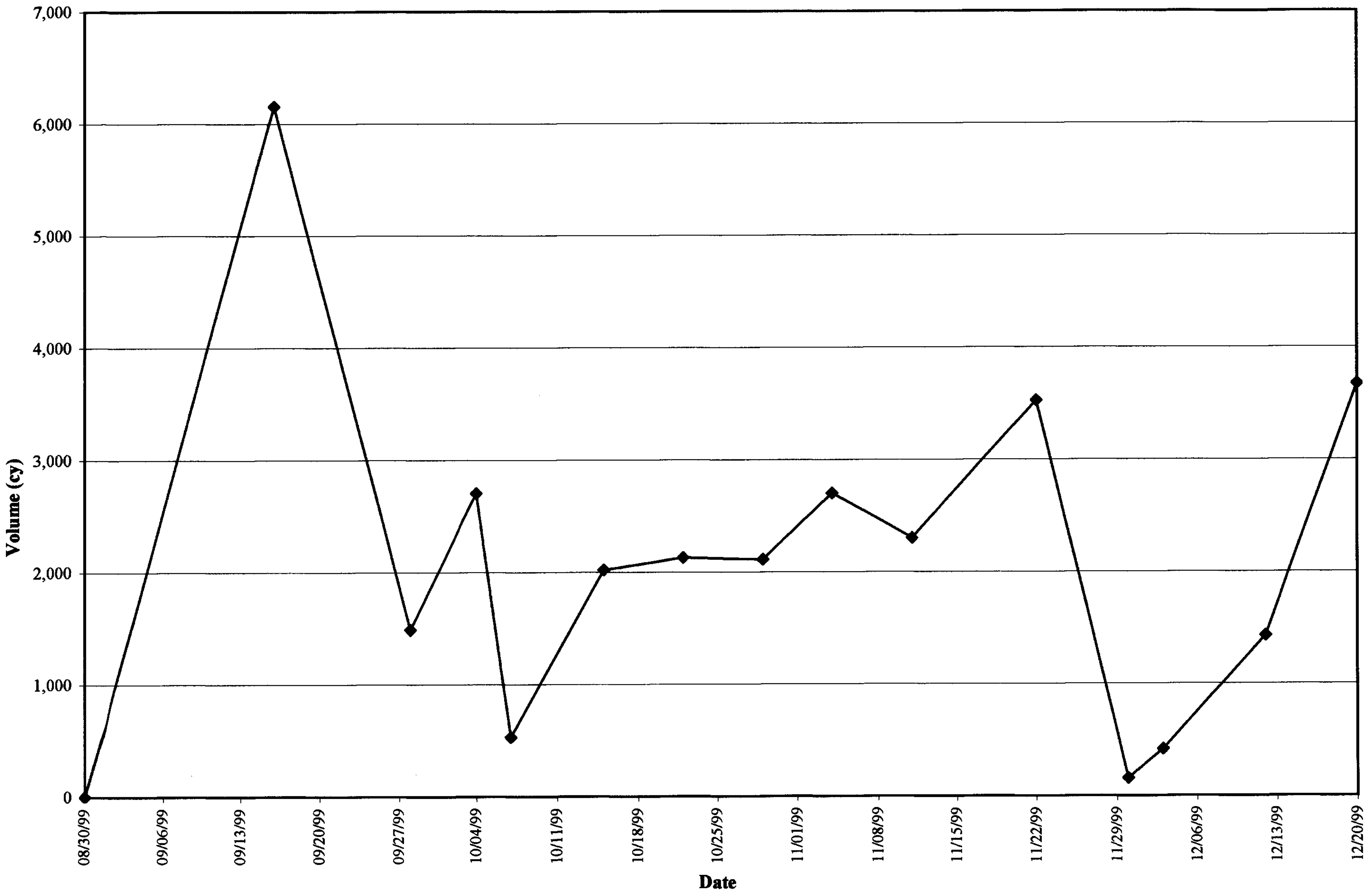

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FIGURE 2 - DREDGING VOLUME - EACH PERIOD

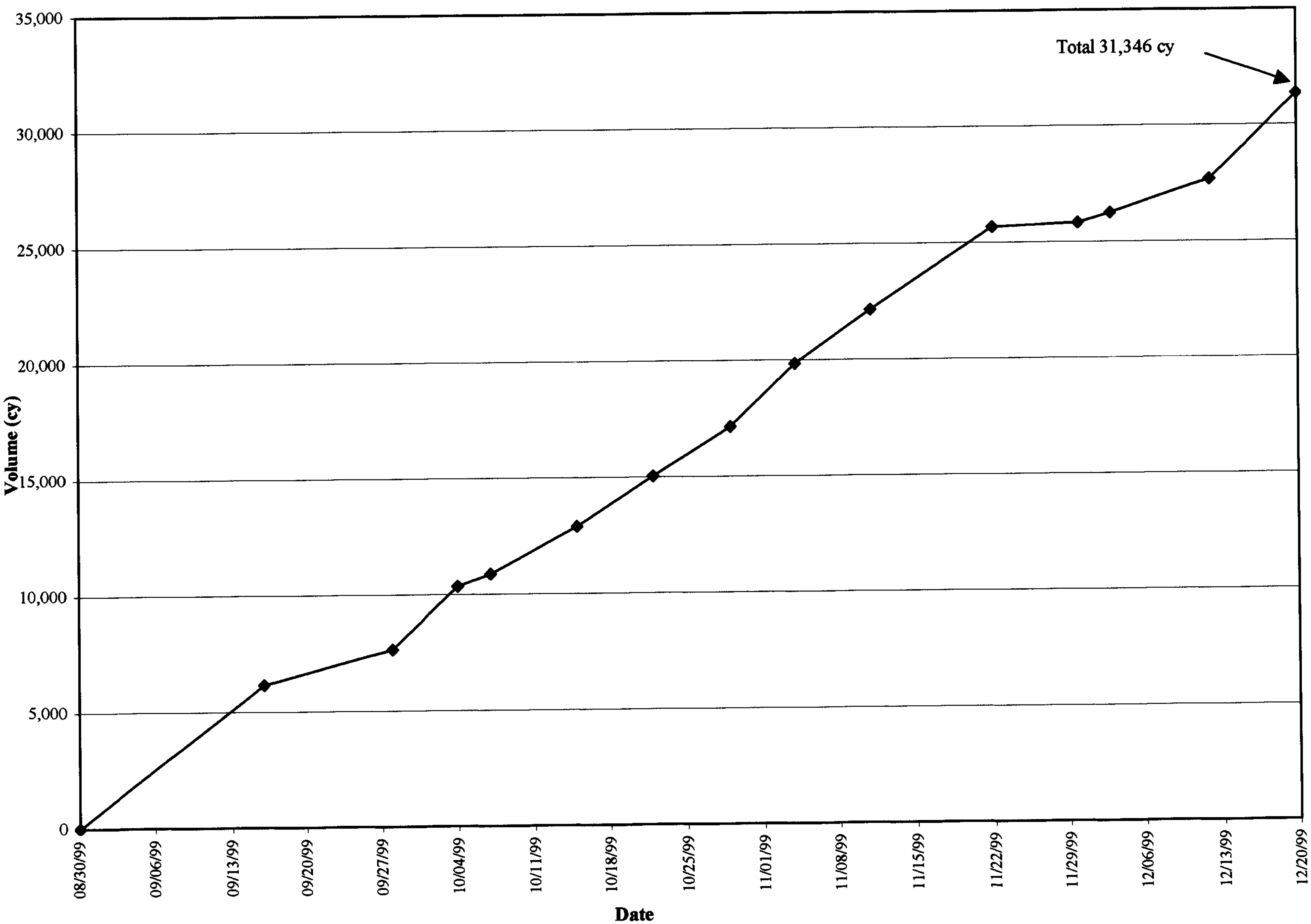

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FIGURE 3 - DREDGING VOLUME - CUMULATIVE

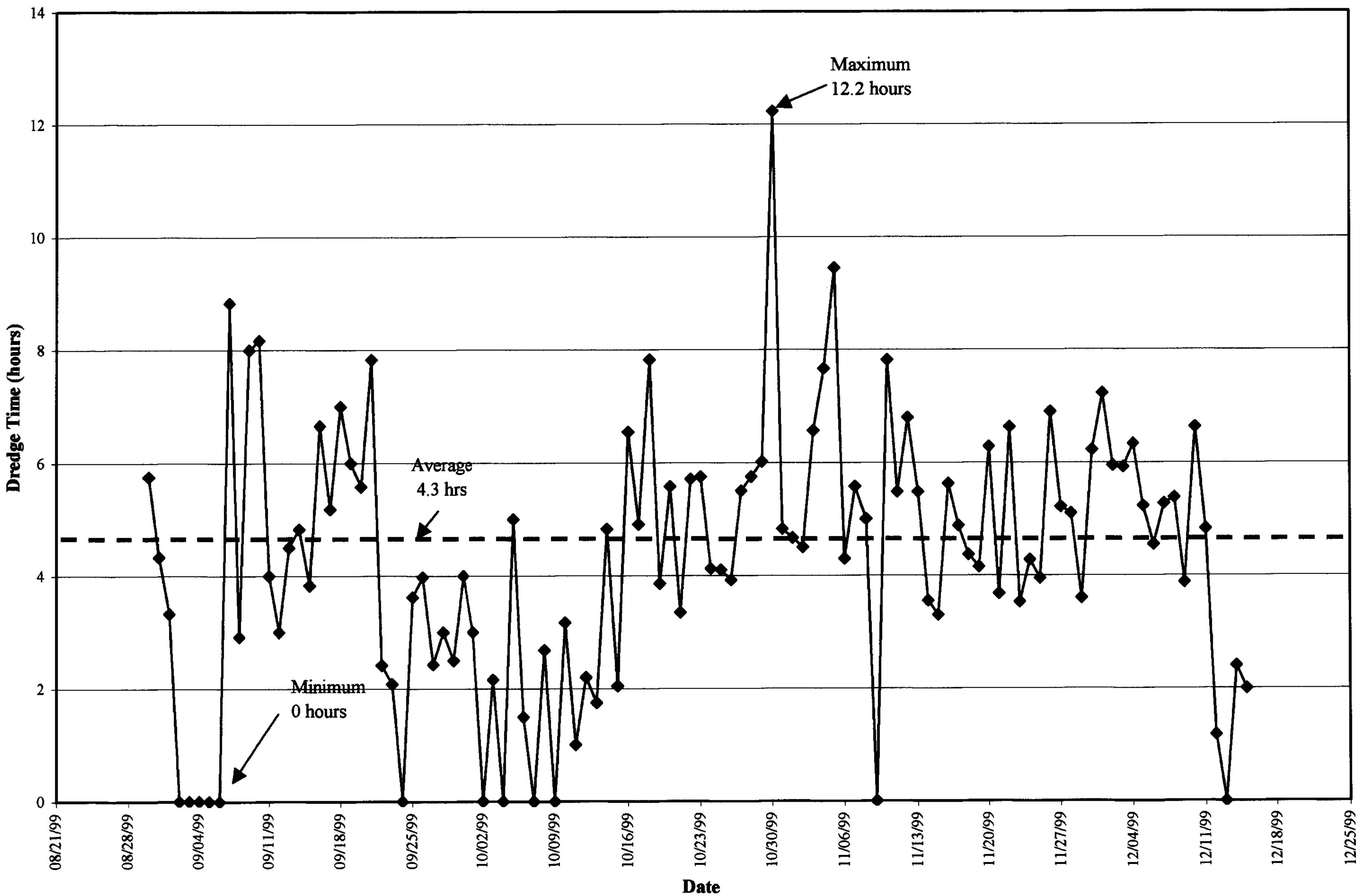

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FIGURE 4 - DREDGE TIME - EACH DAY

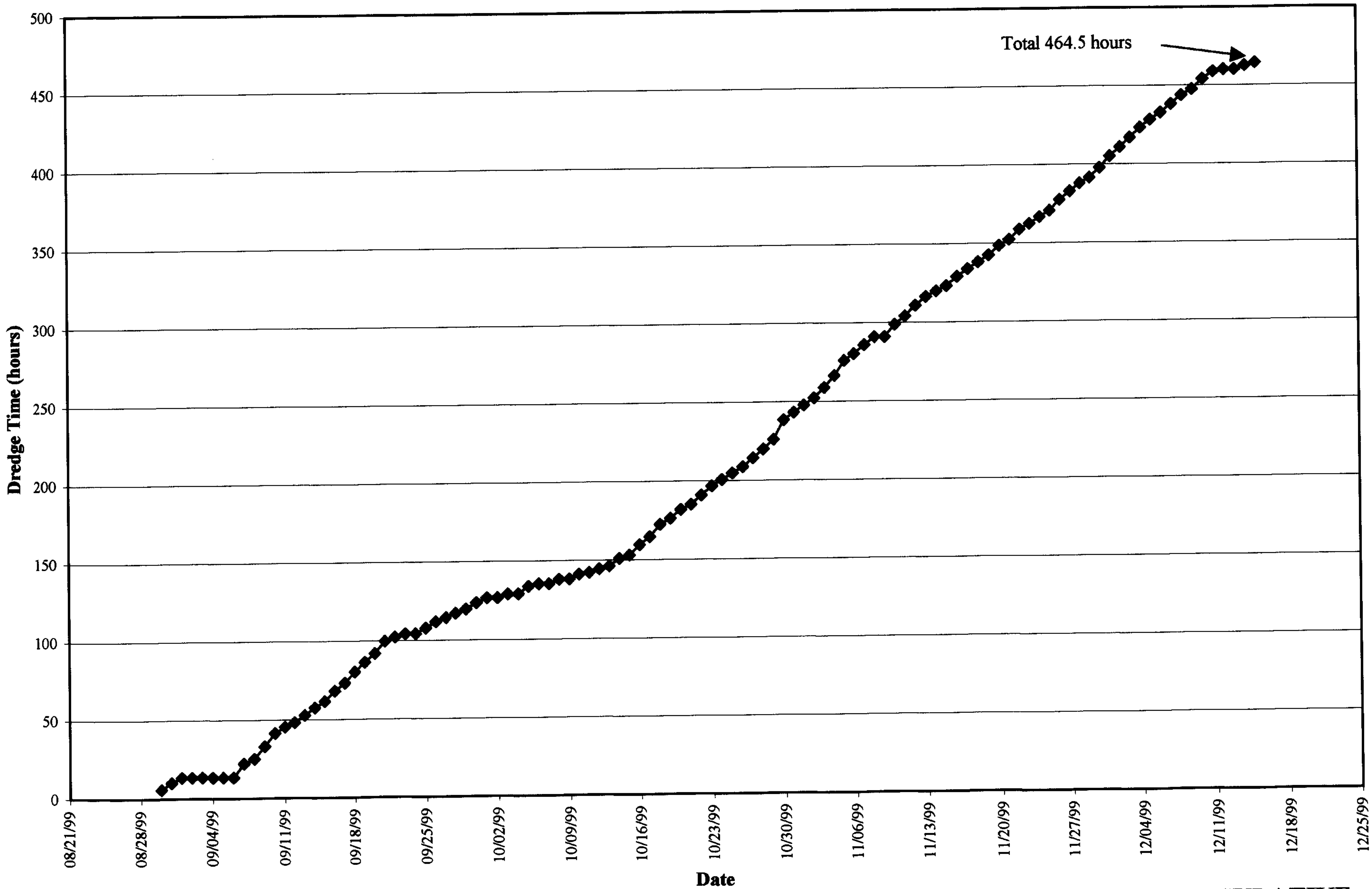

FIGURE 5 - DREDGE TIME - CUMULATIVE

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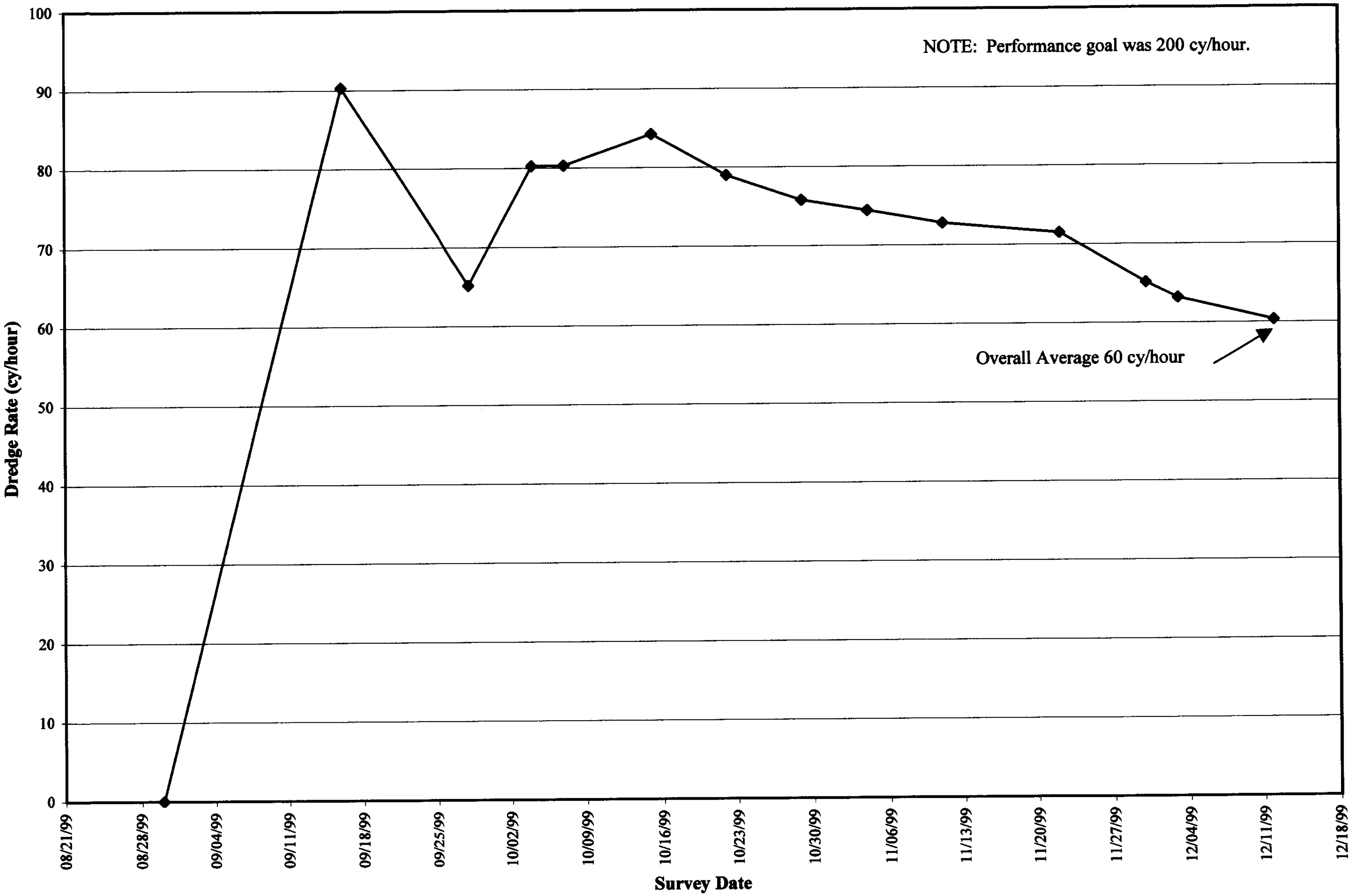

FIGURE 6 - DREDGING RATE - CUMULATIVE (CY/HOUR)

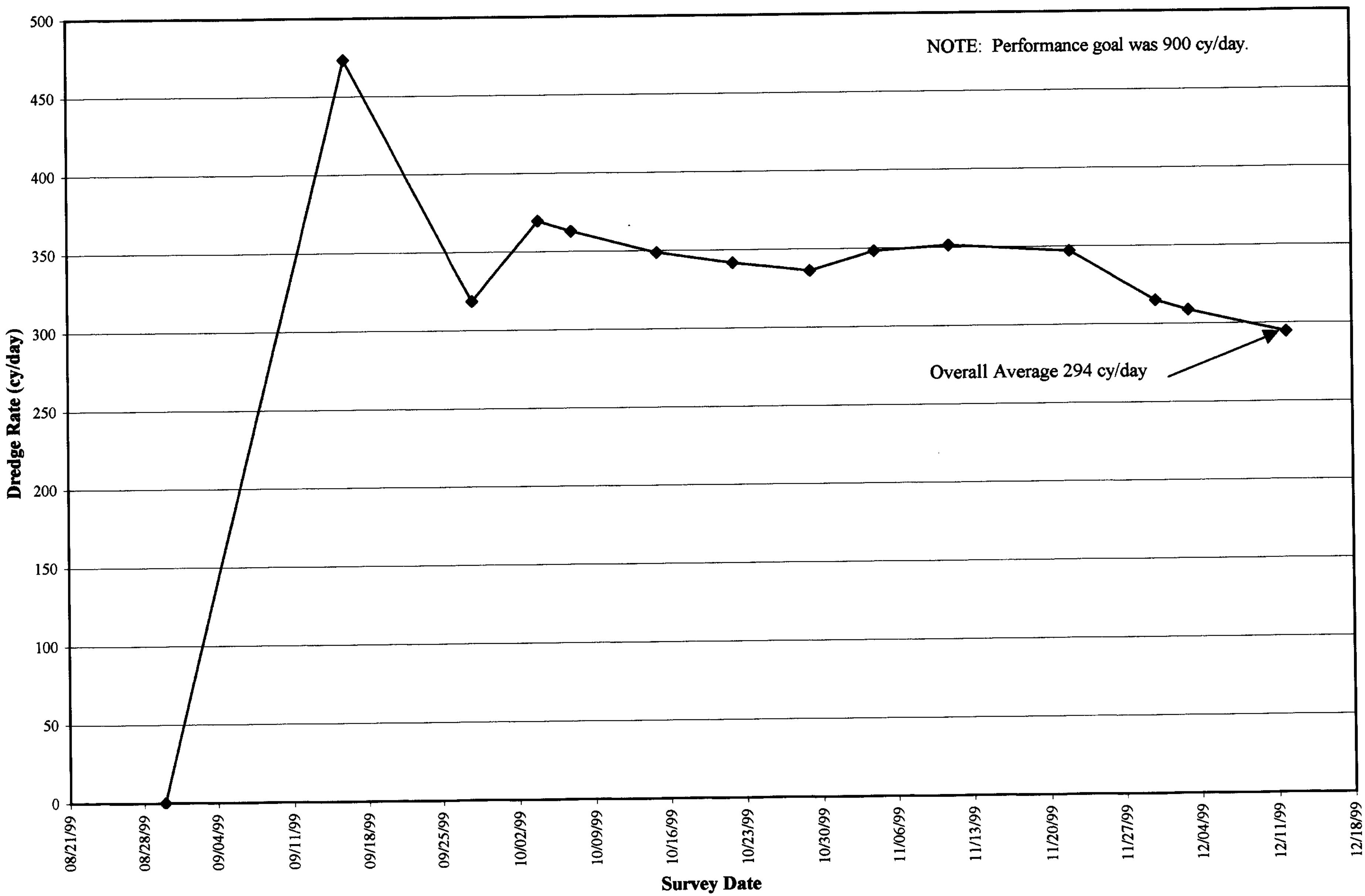

FIGURE 7 - DREDGING RATE - CUMULATIVE (CY/DAY)

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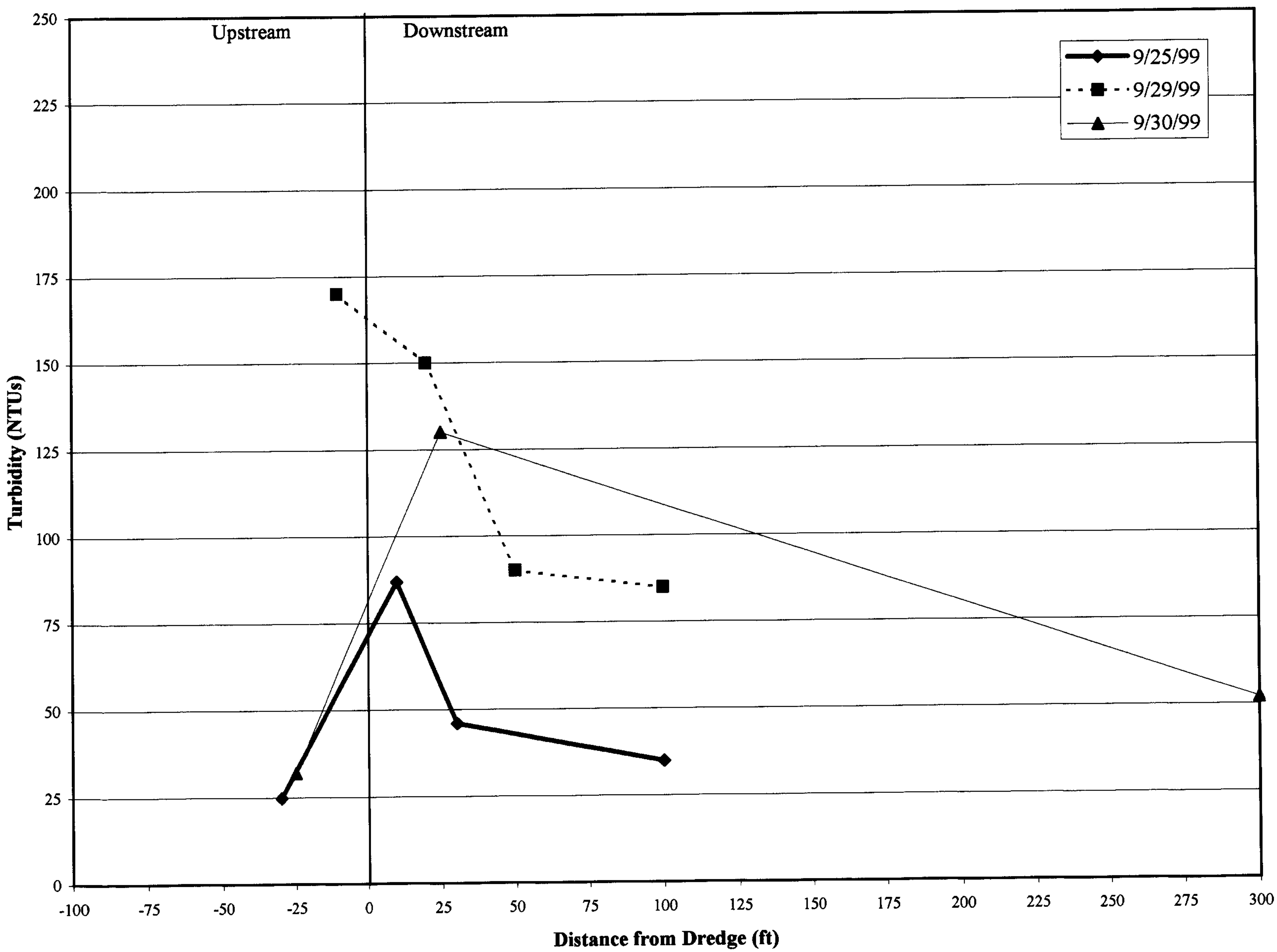

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FIGURE 8 - DISTANCE FROM DREDGE vs. TURBIDITY SEPTEMBER 25, 29, AND 30, 1999

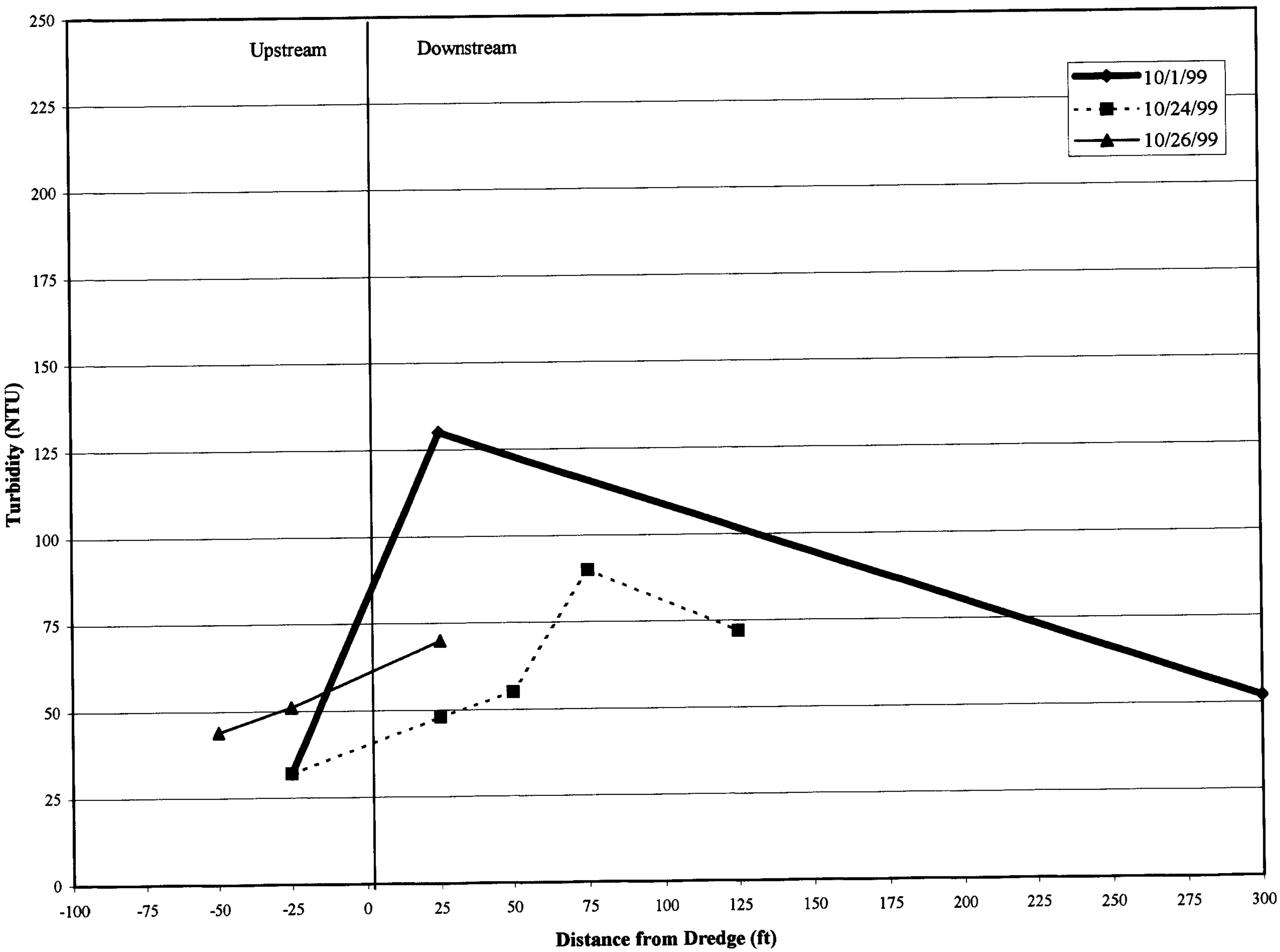

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FIGURE 9 - DISTANCE FROM DREDGE vs. TURBIDITY OCTOBER 1, 24, AND 26, 1999

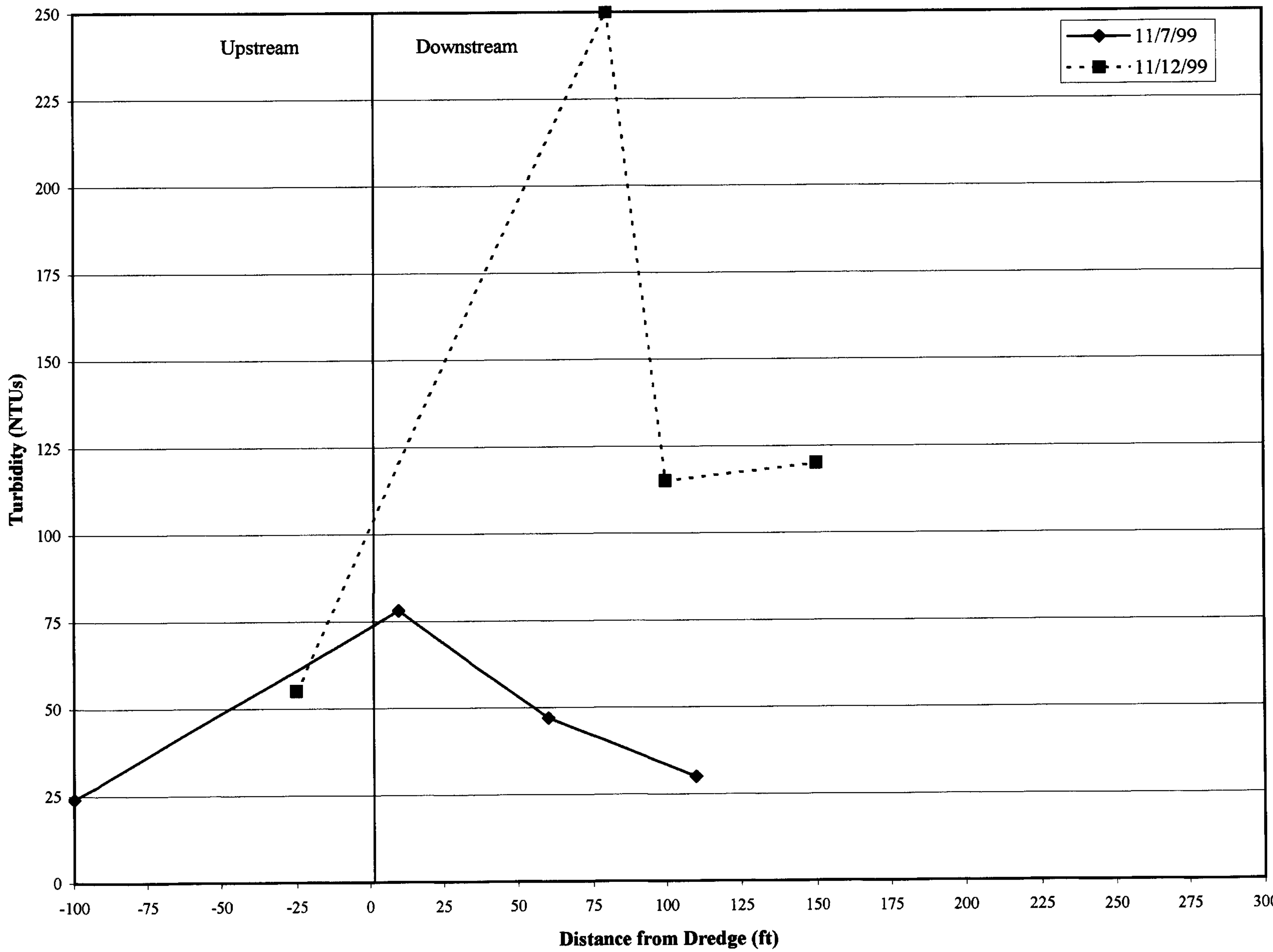

FIGURE 10 - DISTANCE FROM DREDGE vs. TURBIDITY
NOVEMBER 7 AND 12, 1999

MONTGOMERY WATSON

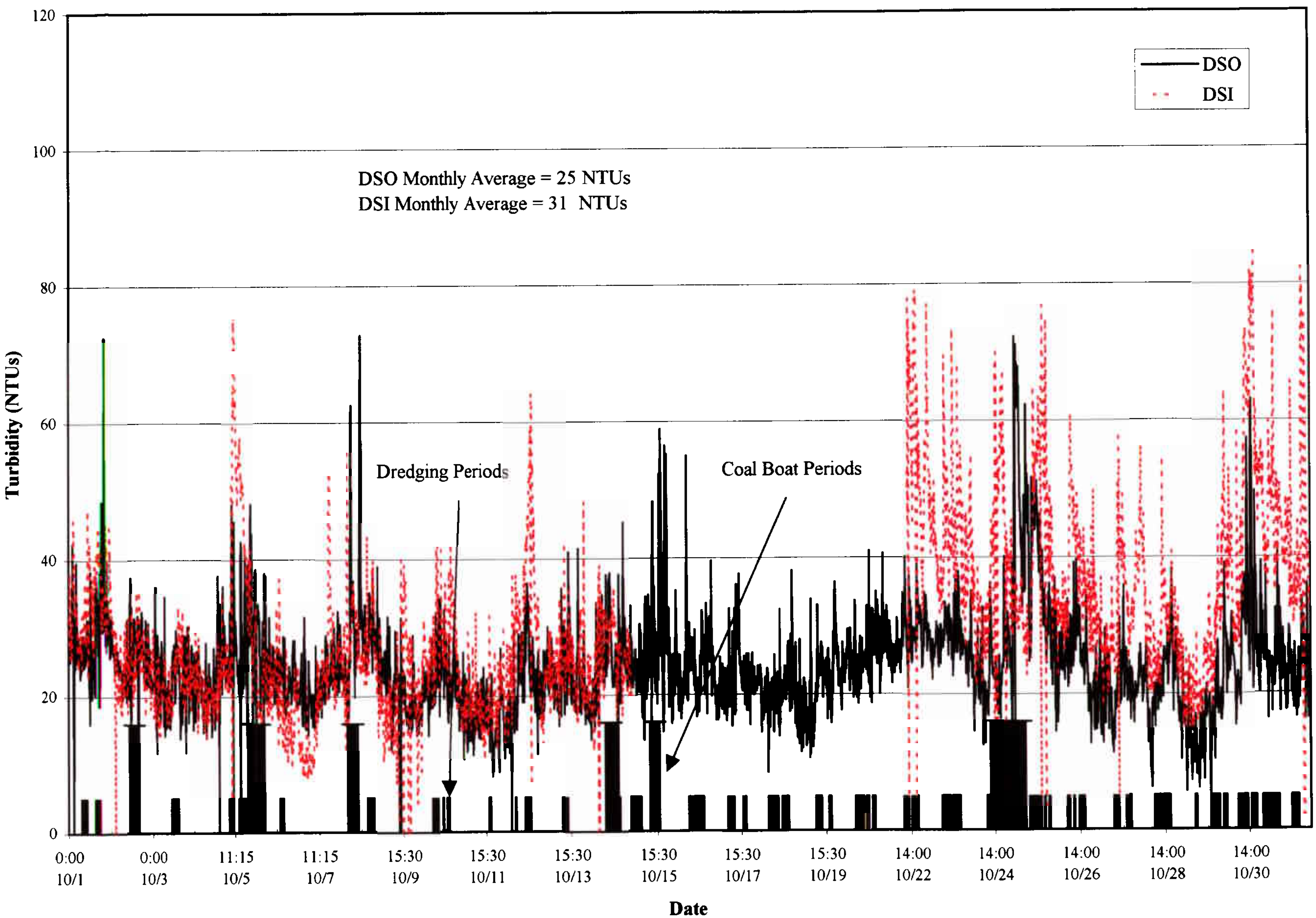

FIGURE 11 - DOWNSTREAM INSIDE (DSI) AND DOWNSTREAM OUTSIDE (DSO) TURBIDITY FOR OCTOBER 1999

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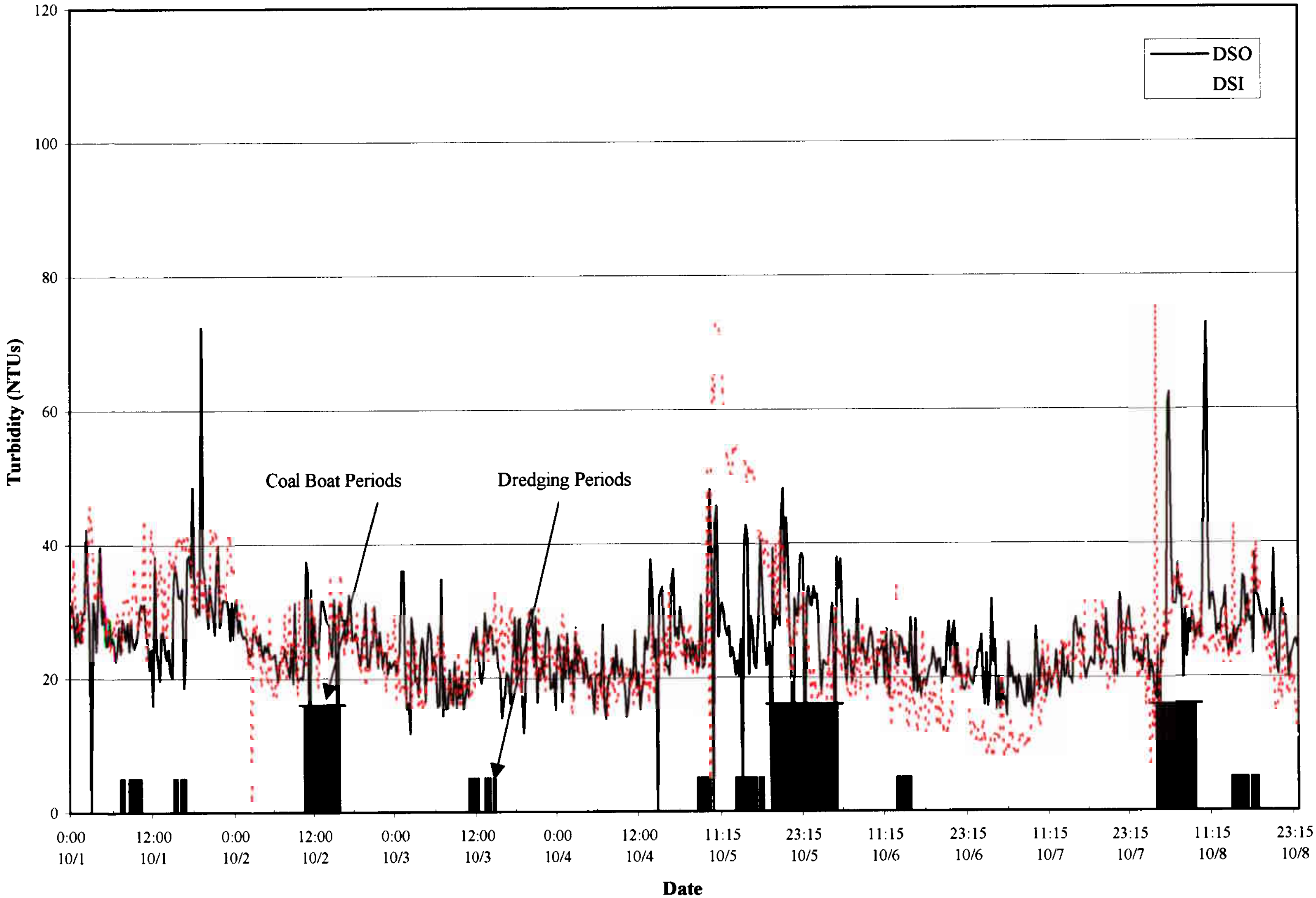

FIGURE 12 - DOWNSTREAM INSIDE (DSI) AND DOWNSTRAM OUTSIDE (DSO) TURBIDITY FOR OCTOBER 1-8, 1999

MONTGOMERY WATSON

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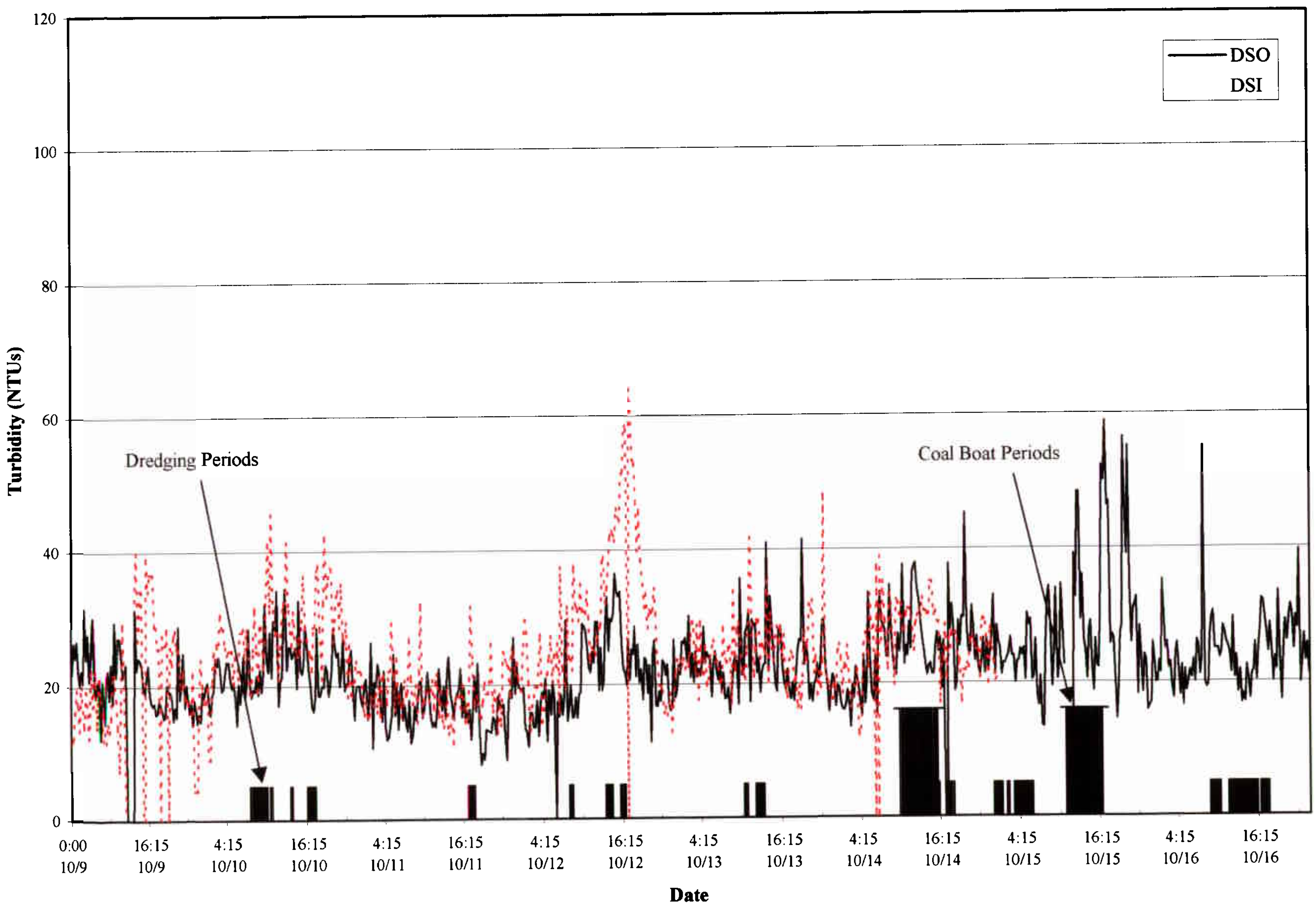


FIGURE 13 - DOWNSTREAM INSIDE (DSI) AND DOWNSTREAM OUTSIDE (DSO) TURBIDITY FOR OCTOBER 9-16, 1999

MONTGOMERY WATSON

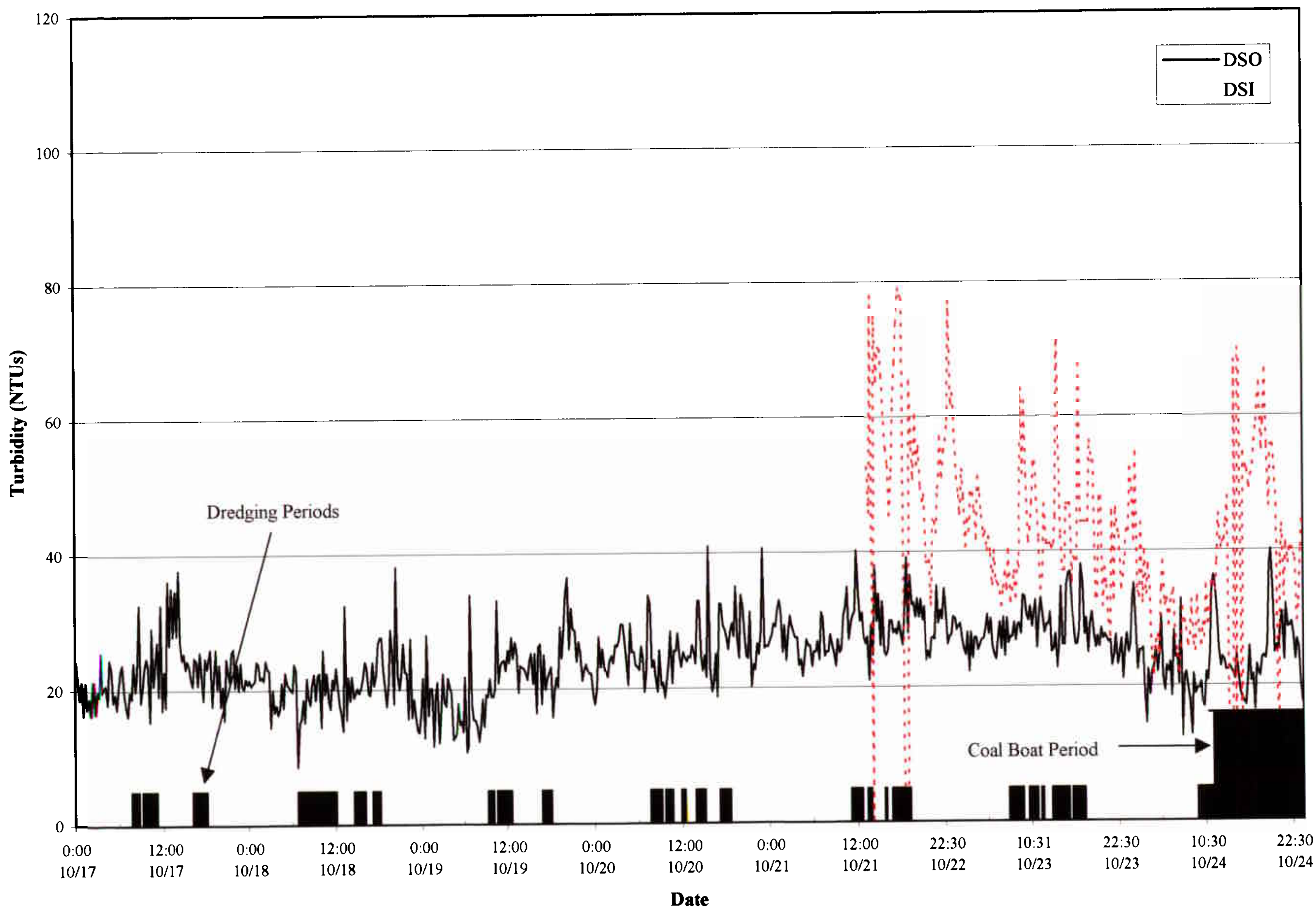


FIGURE 14 - DOWNSTREAM INSIDE (DSI) AND DOWNSTREAM OUTSIDE (DSO) TURBIDITY FOR OCTOBER 17-24, 1999

AMS/jlv/RHW || N:/jobs/208/2057/01/wp/fig/Figure 15.xls

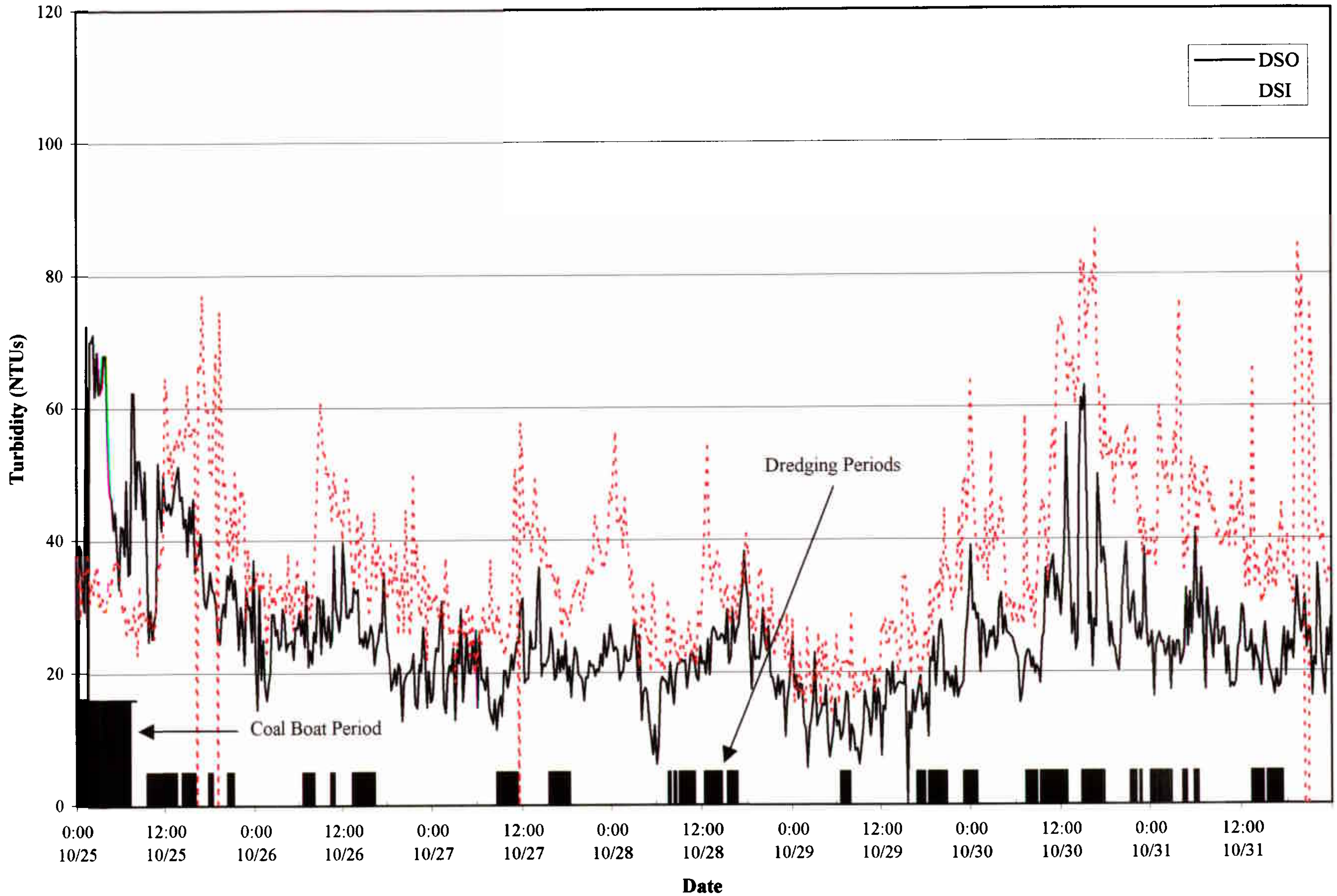
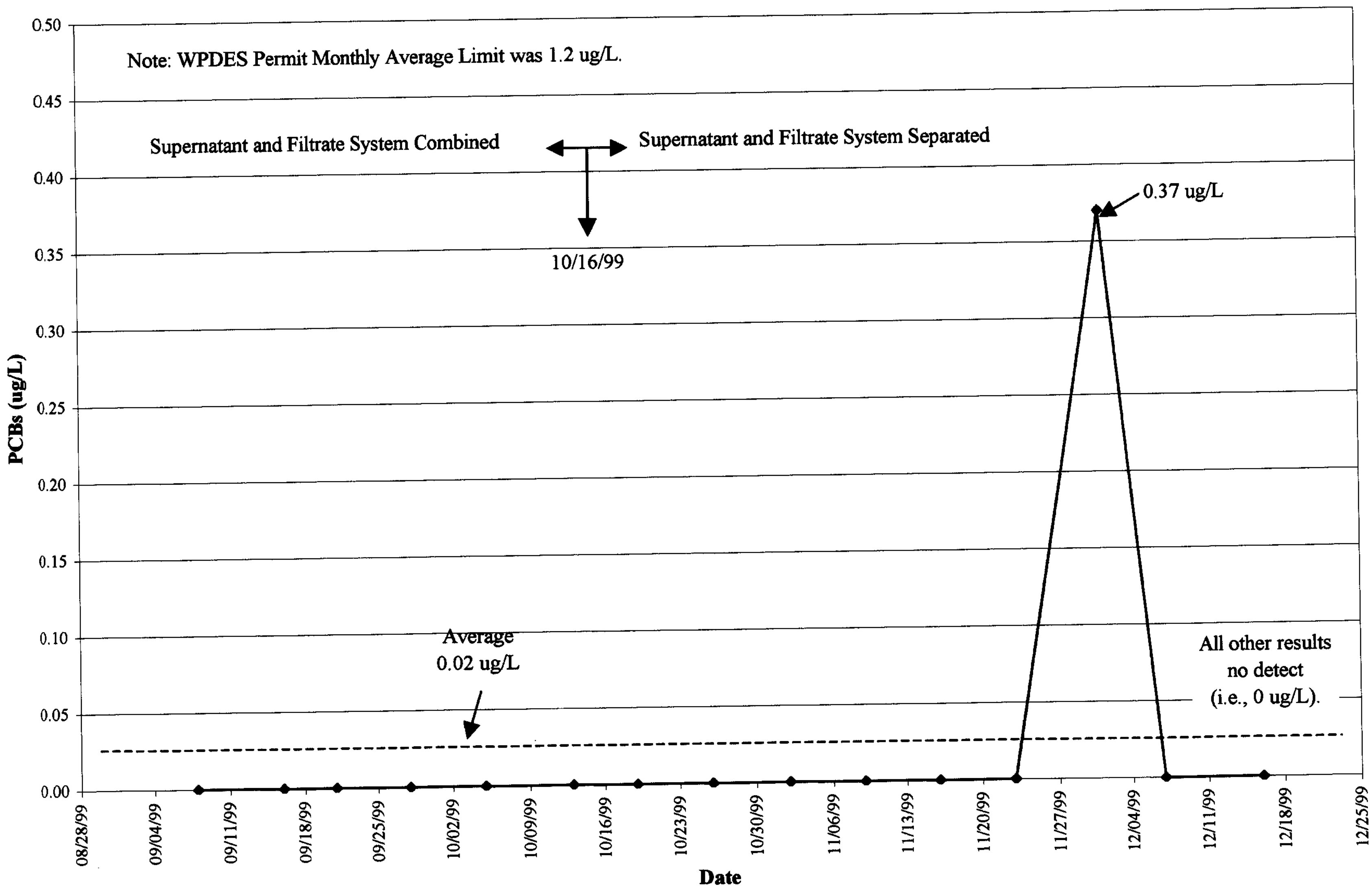


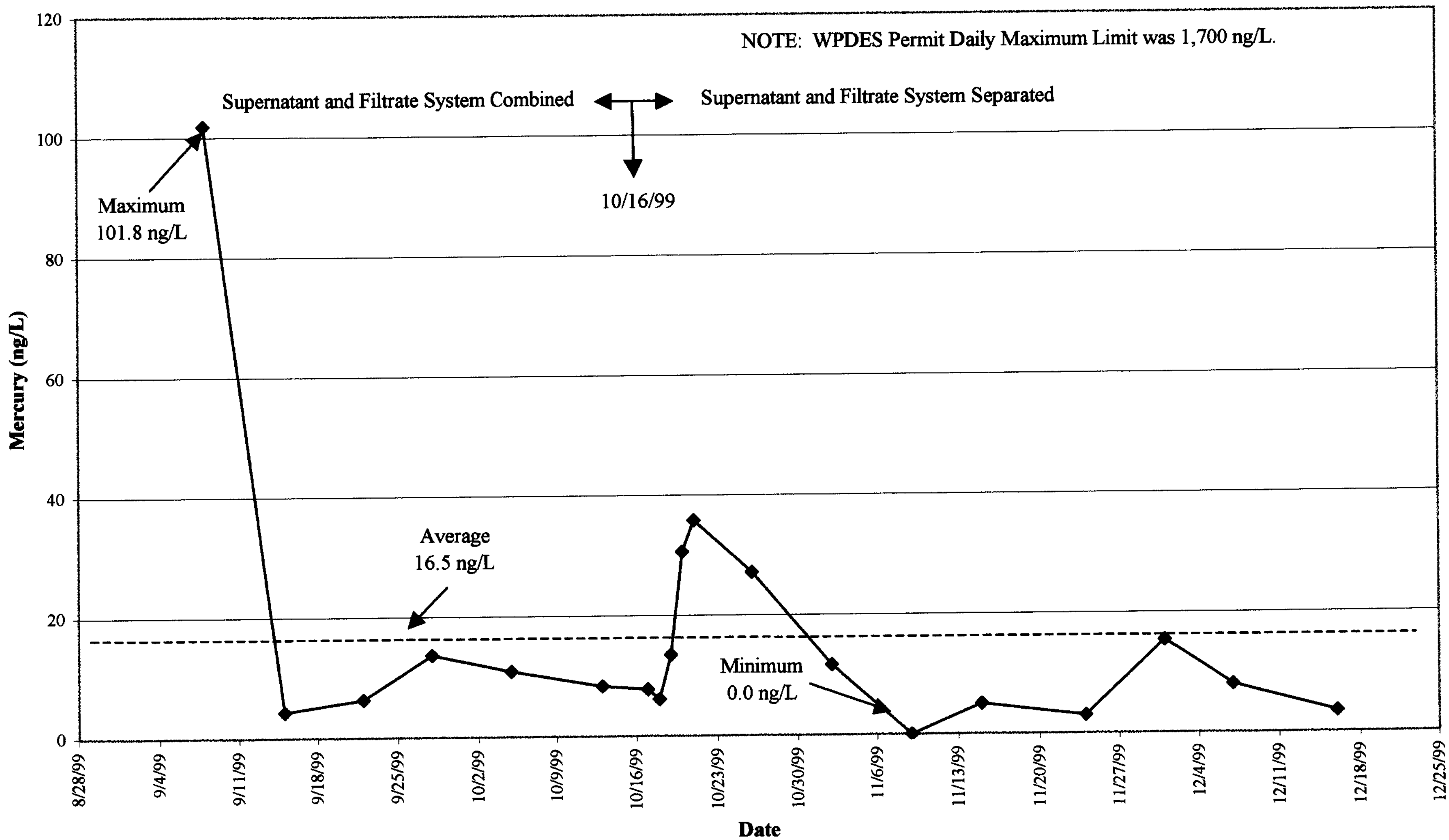
FIGURE 15 - DOWNSTREAM INSIDE (DSI) AND DOWNSTREAM OUTSIDE (DSO) TURBIDITY FOR OCTOBER 25-31, 1999

MONTGOMERY WATSON



MONTGOMERY WATSON

FIGURE 16 - EFFLUENT WATER (001) PCBs



MONTGOMERY WATSON

FIGURE 17 - EFFLUENT WATER (001) MERCURY

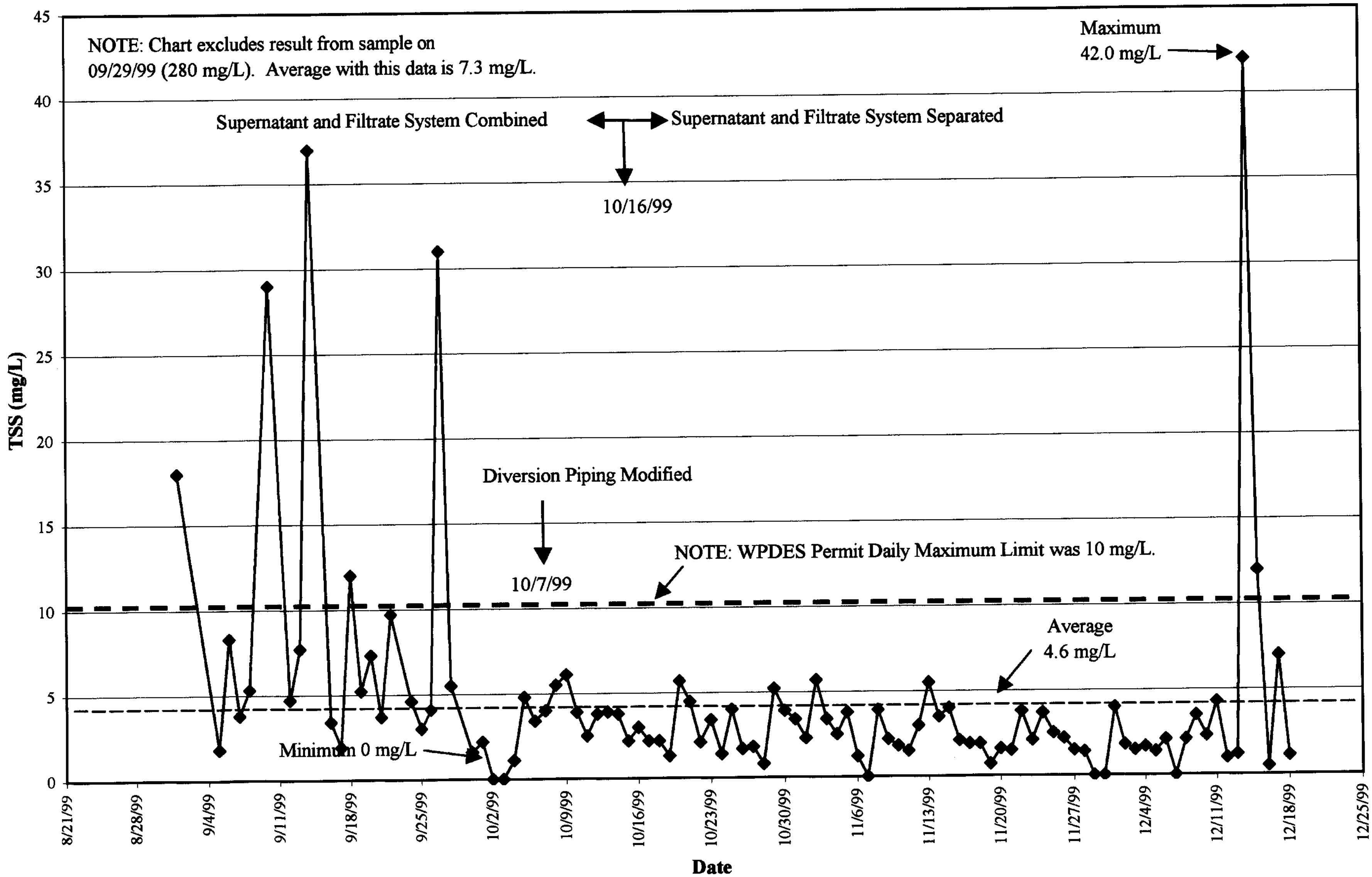


FIGURE 18 - EFFLUENT WATER (001) TOTAL SUSPENDED SOLIDS

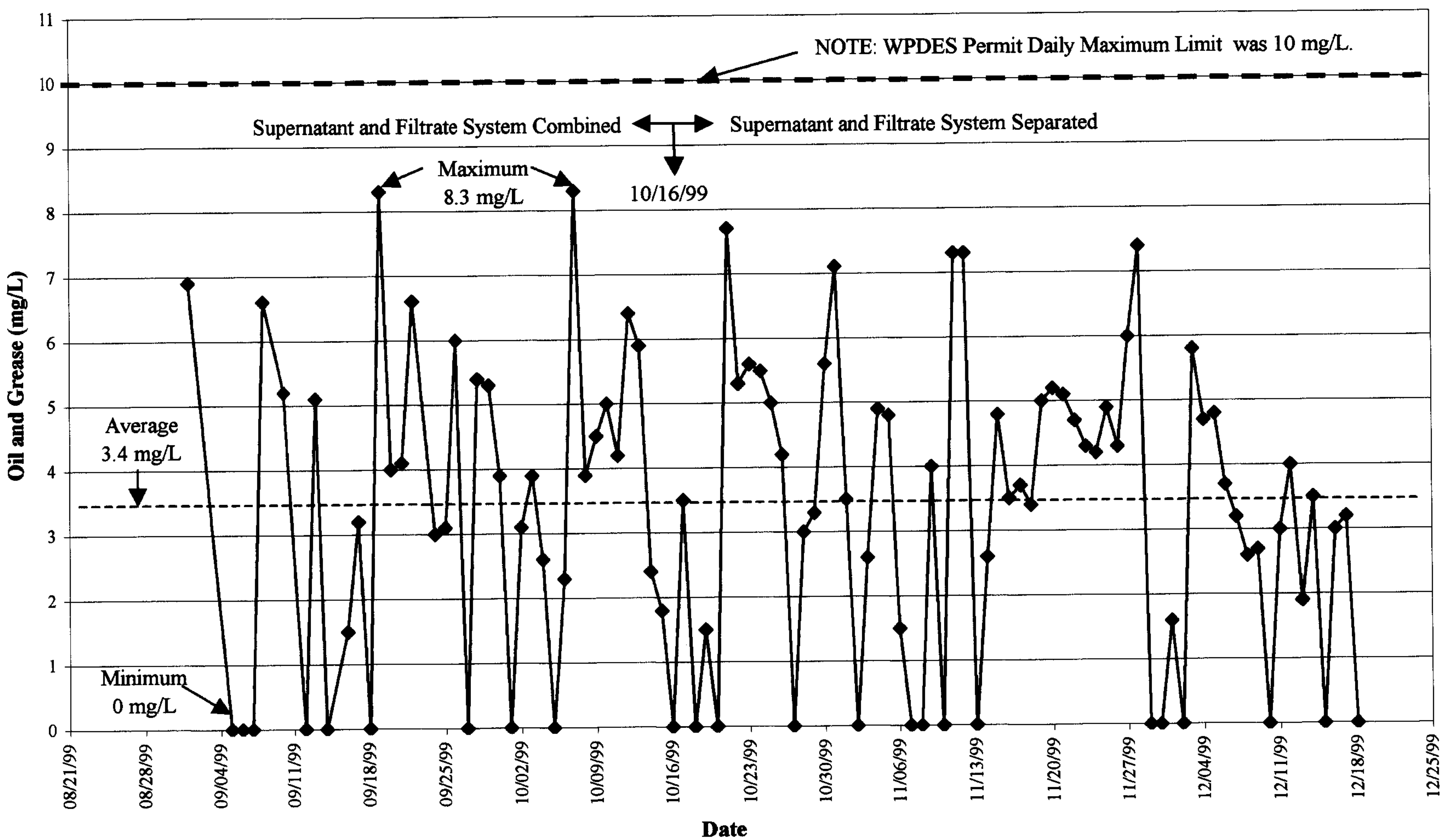


FIGURE 19 - EFFLUENT WATER (001) OIL AND GREASE

MONTGOMERY WATSON

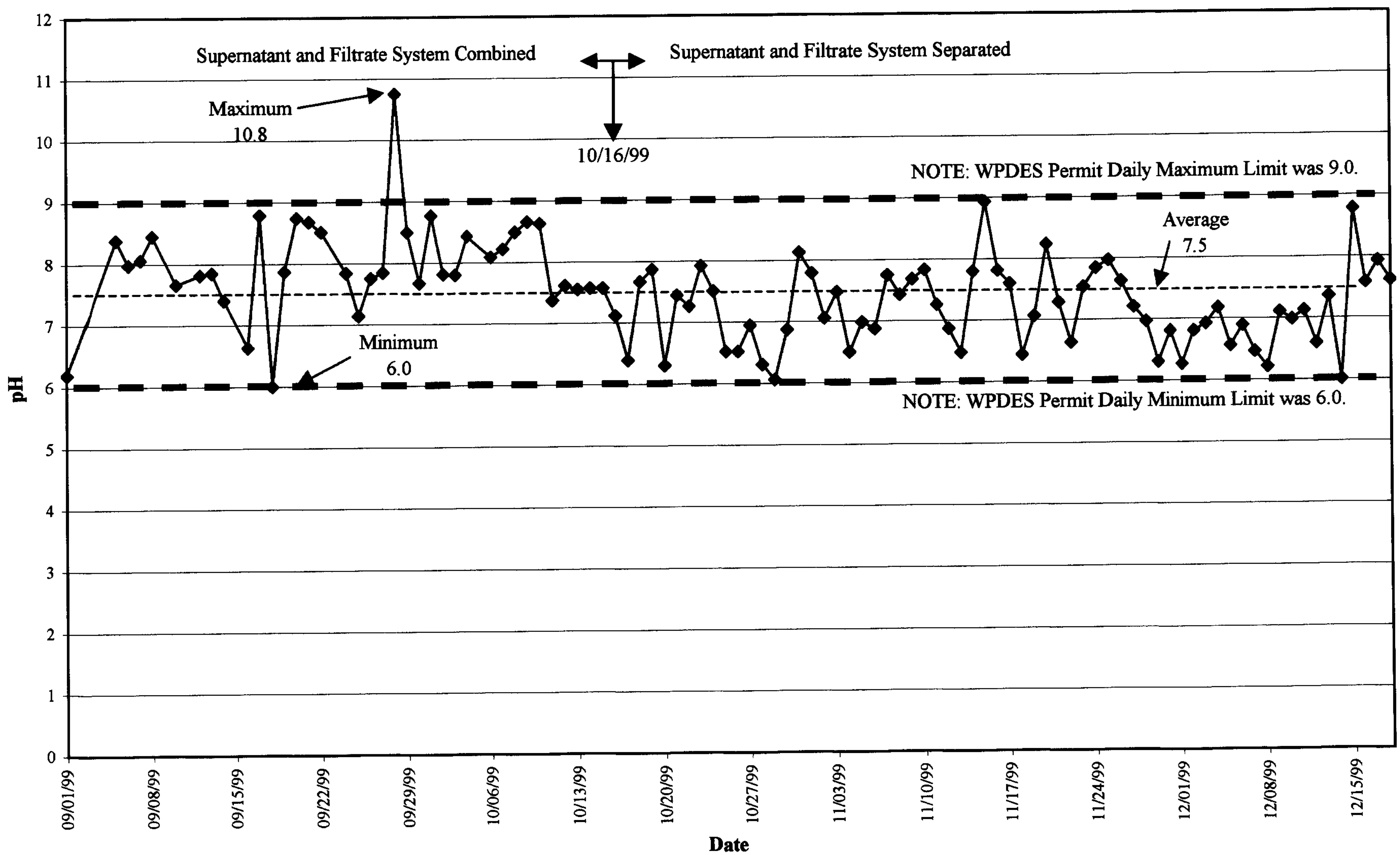
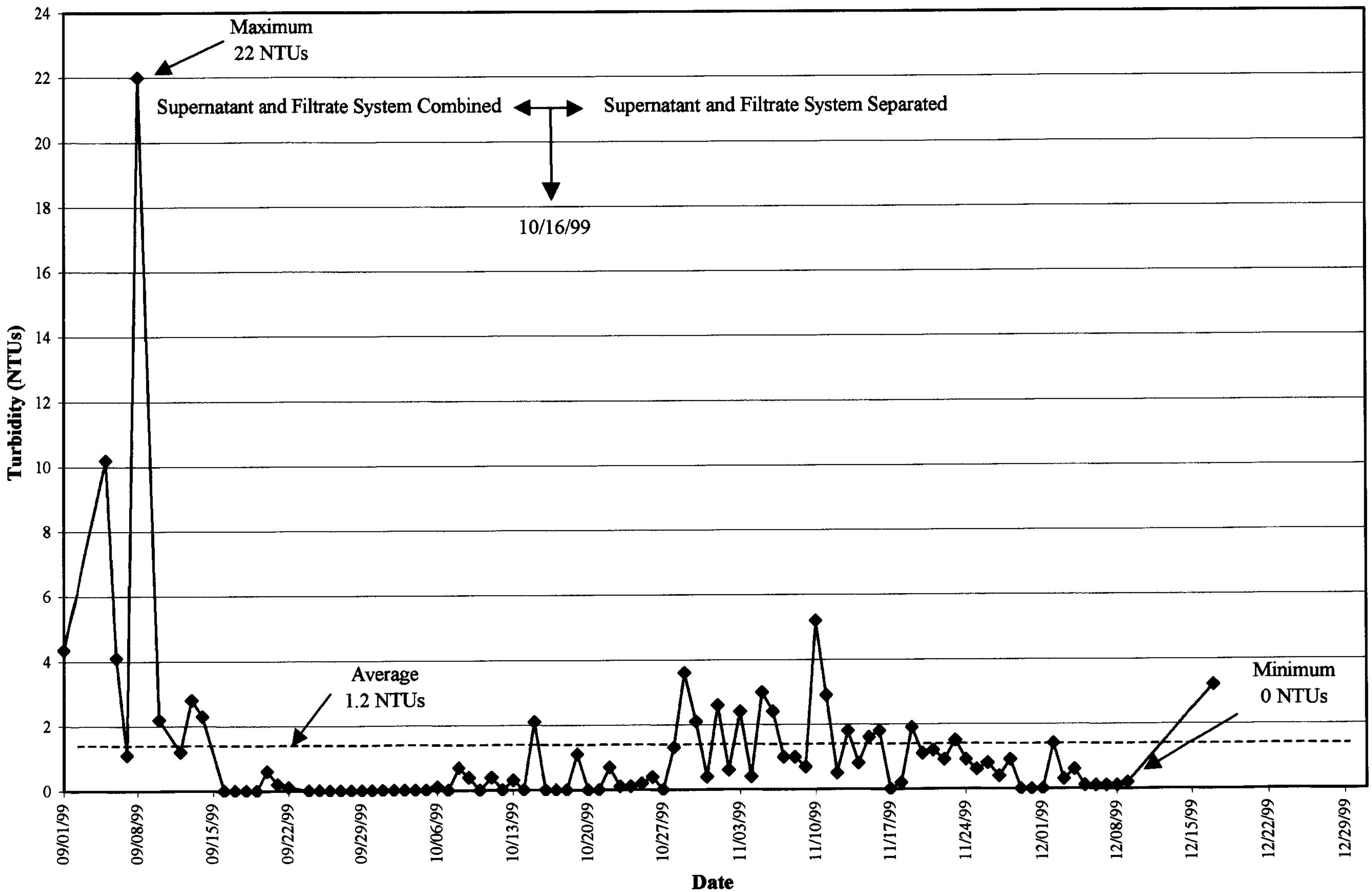


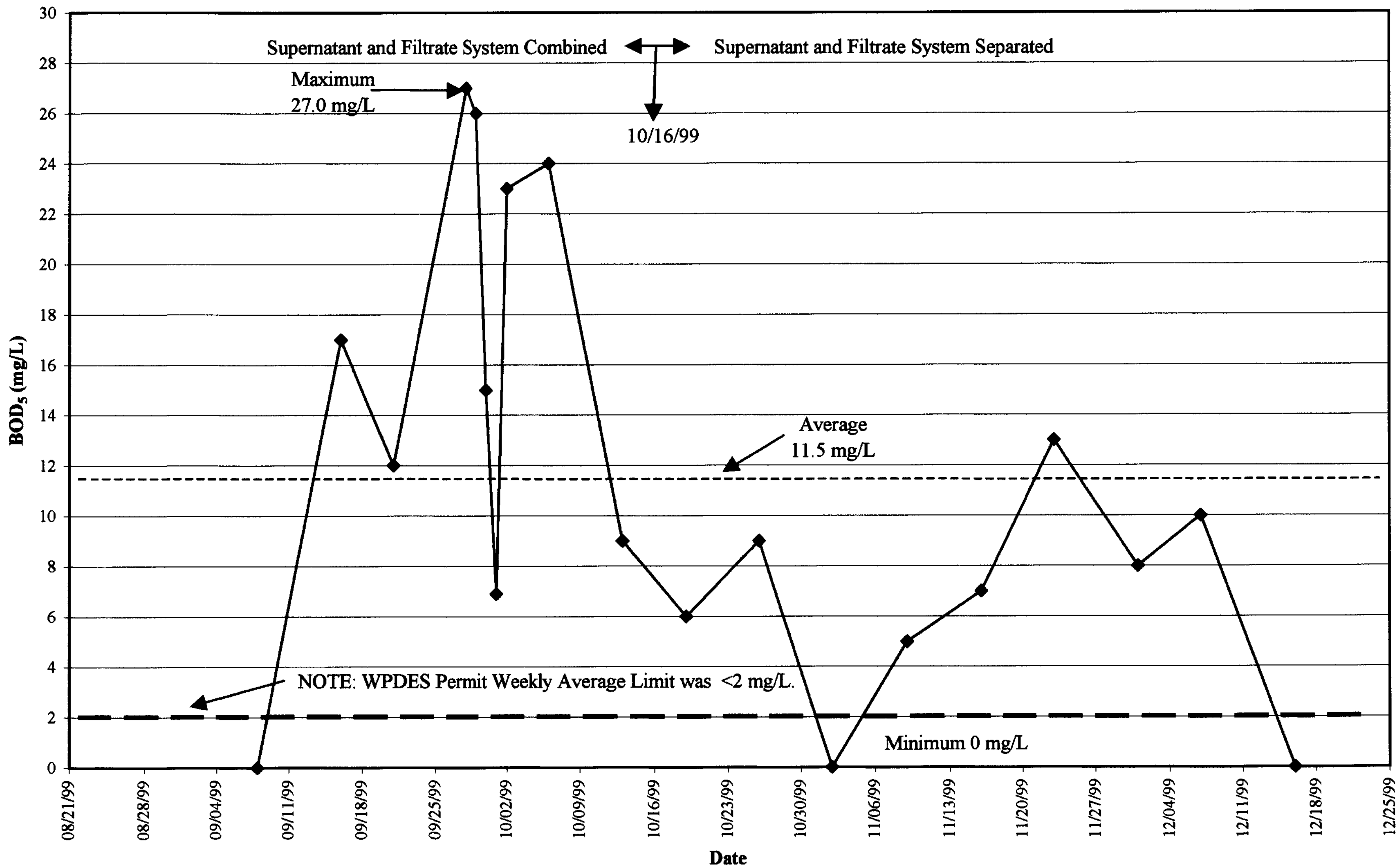
FIGURE 20 - EFFLUENT WATER (001) pH

JLV/ams/jlv/RHW || N:/jobs/208/2057/01/wp/fig/Figure 21.xls



MONTGOMERY WATSON

FIGURE 21 - EFFLUENT WATER (001) TURBIDITY



MONTGOMERY WATSON

FIGURE 22 - EFFLUENT WATER (001) BOD_5

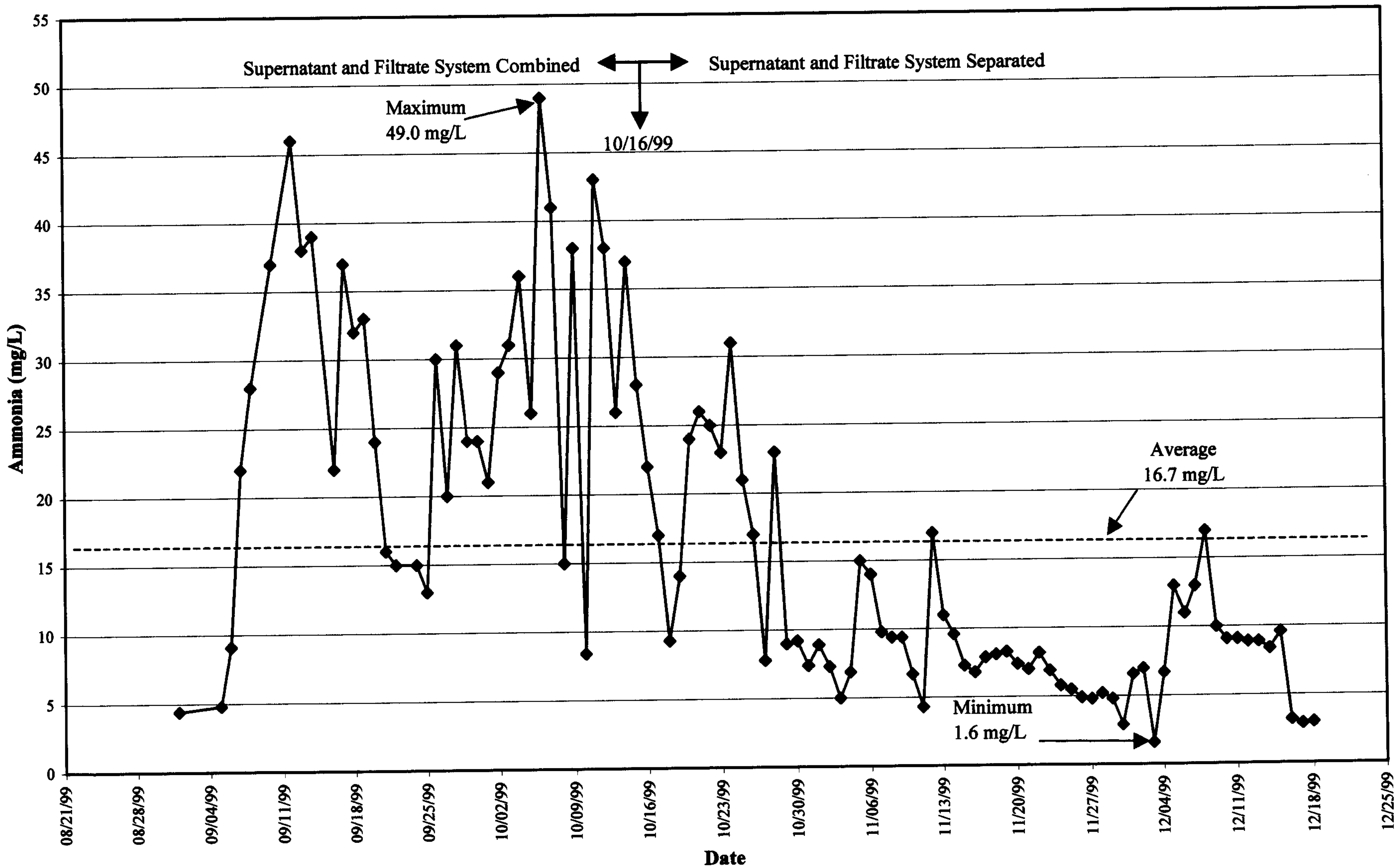
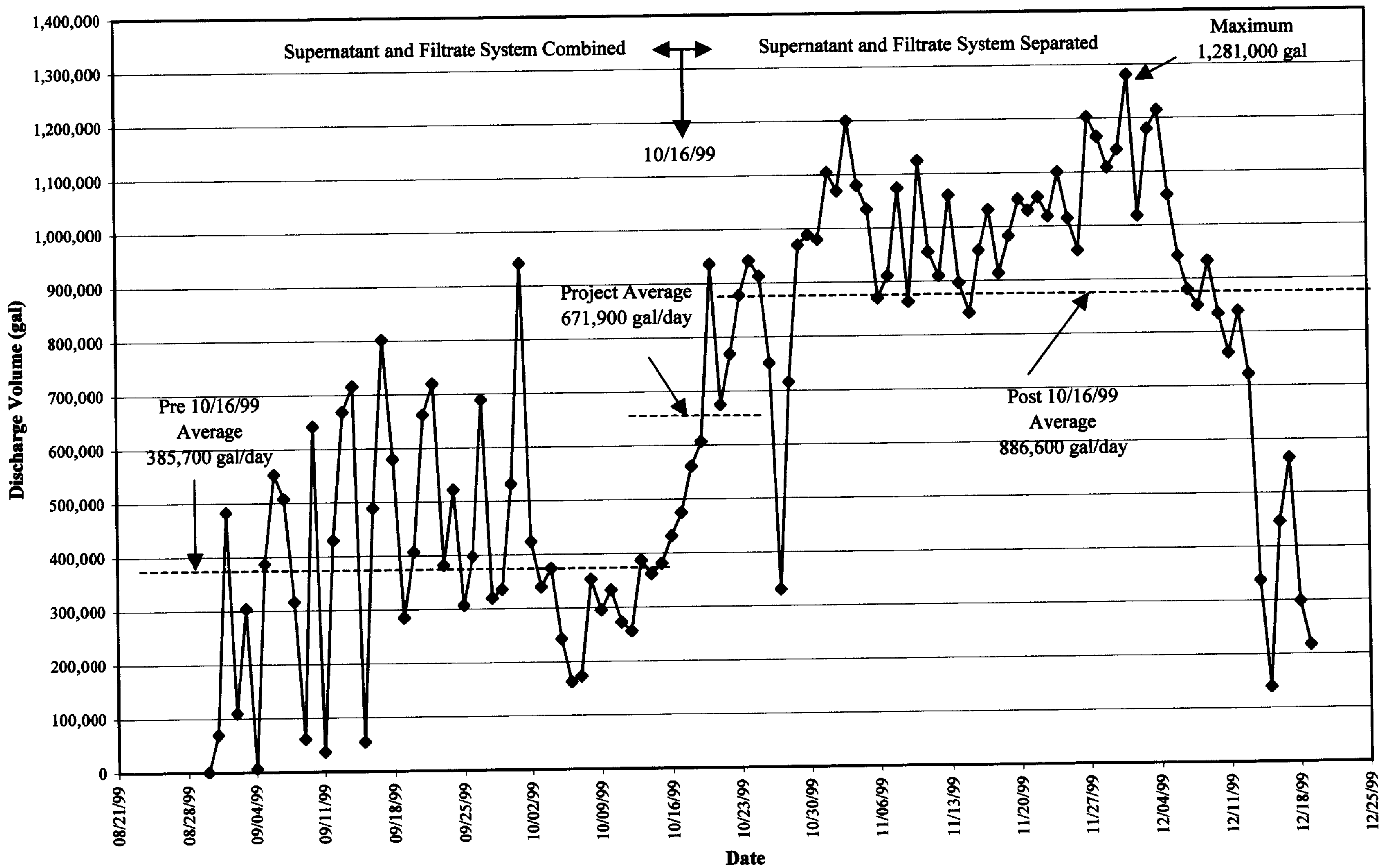


FIGURE 23 - EFFLUENT WATER (001) AMMONIA NITROGEN

MONTGOMERY WATSON



MONTGOMERY WATSON

FIGURE 24 - EFFLUENT WATER (001) DISCHARGE VOLUME- DAILY

JLV/jlv/RHW || N:/jobs/208/2057/01/wp/fig/Figure 25.xls

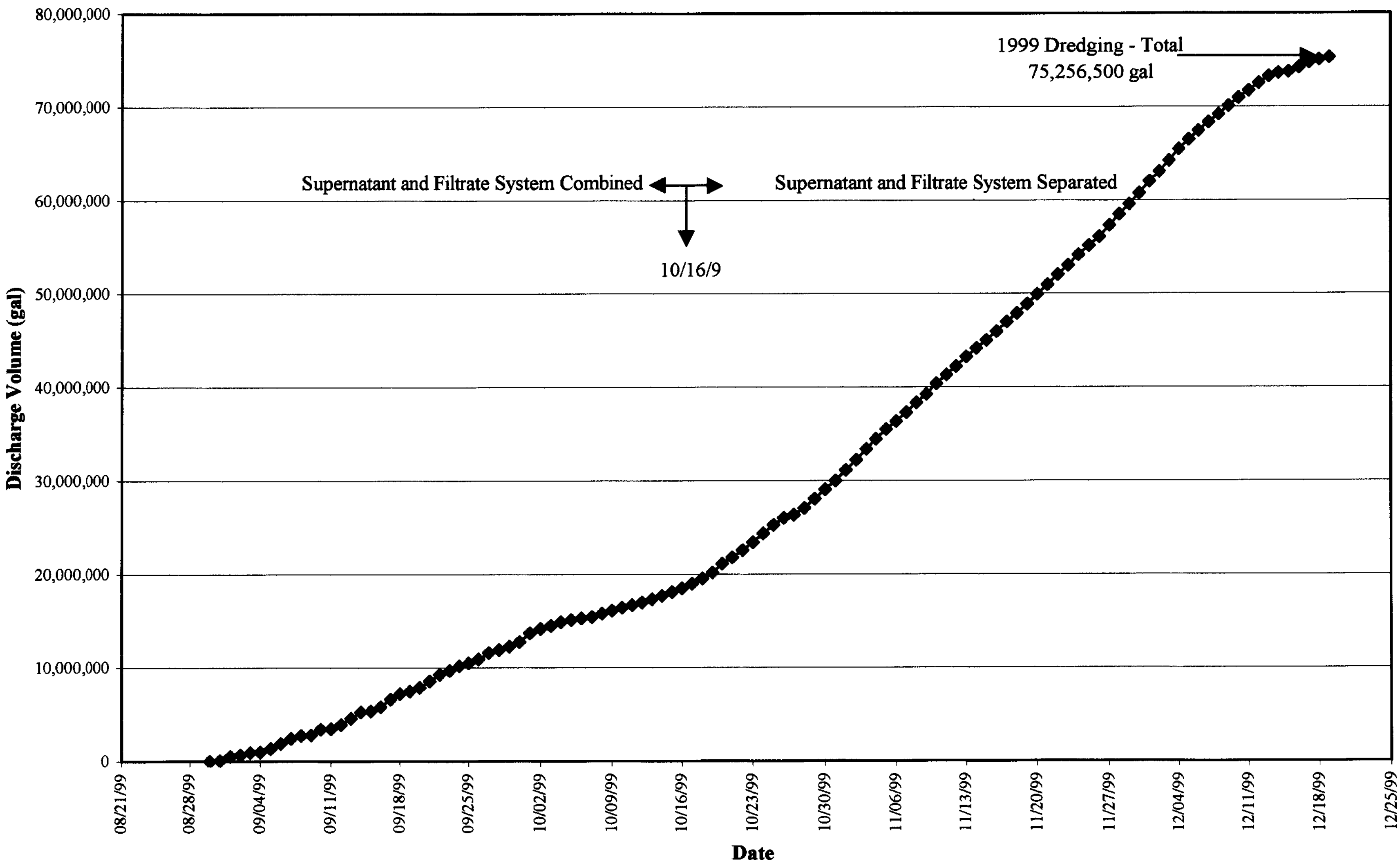
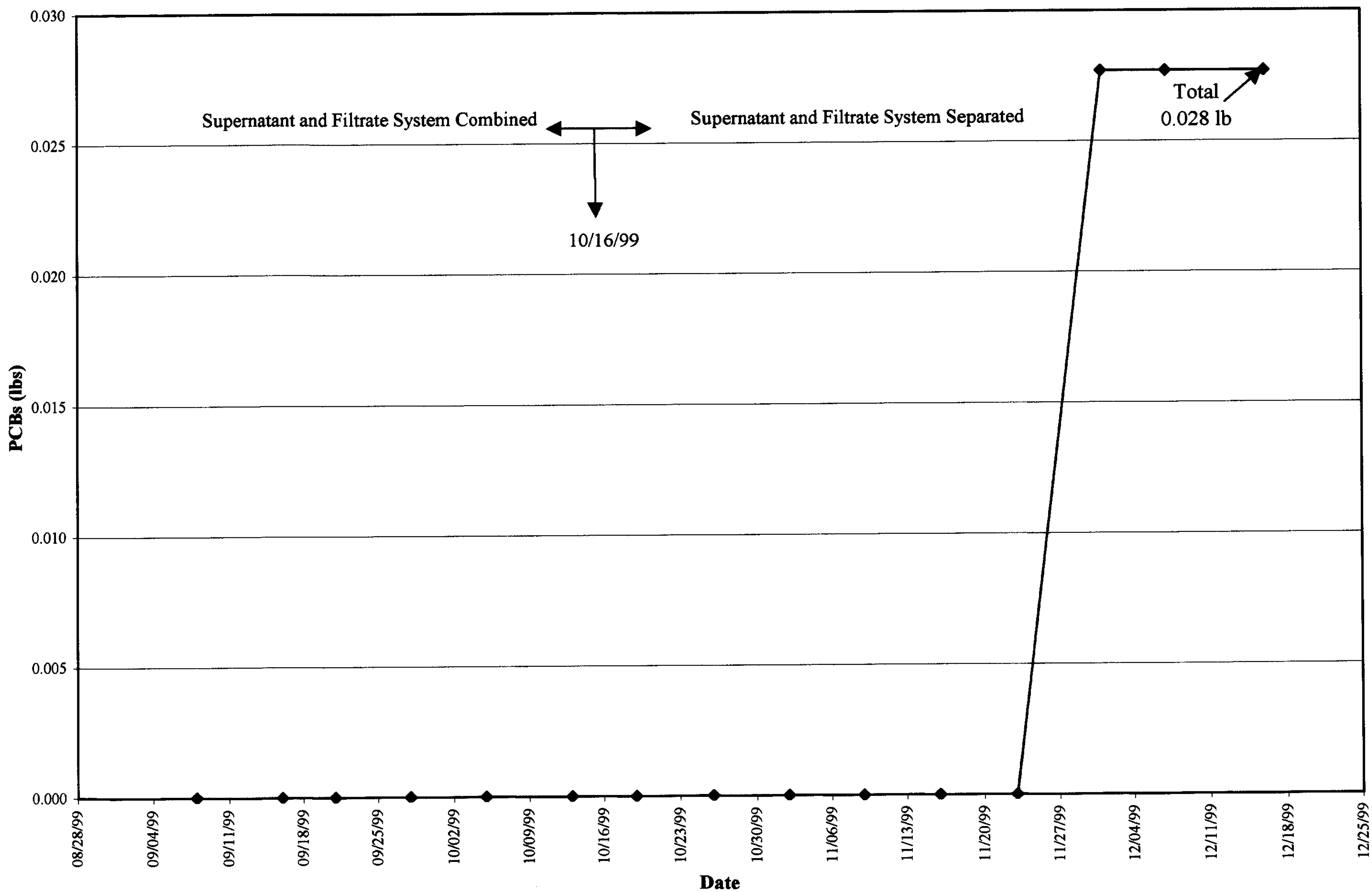


FIGURE 25 - EFFLUENT WATER (001)
DISCHARGE VOLUME - CUMULATIVE

MONTGOMERY WATSON



MONTGOMERY WATSON

FIGURE 26 - EFFLUENT WATER (001)
PCB MASS DISCHARGED - CUMULATIVE

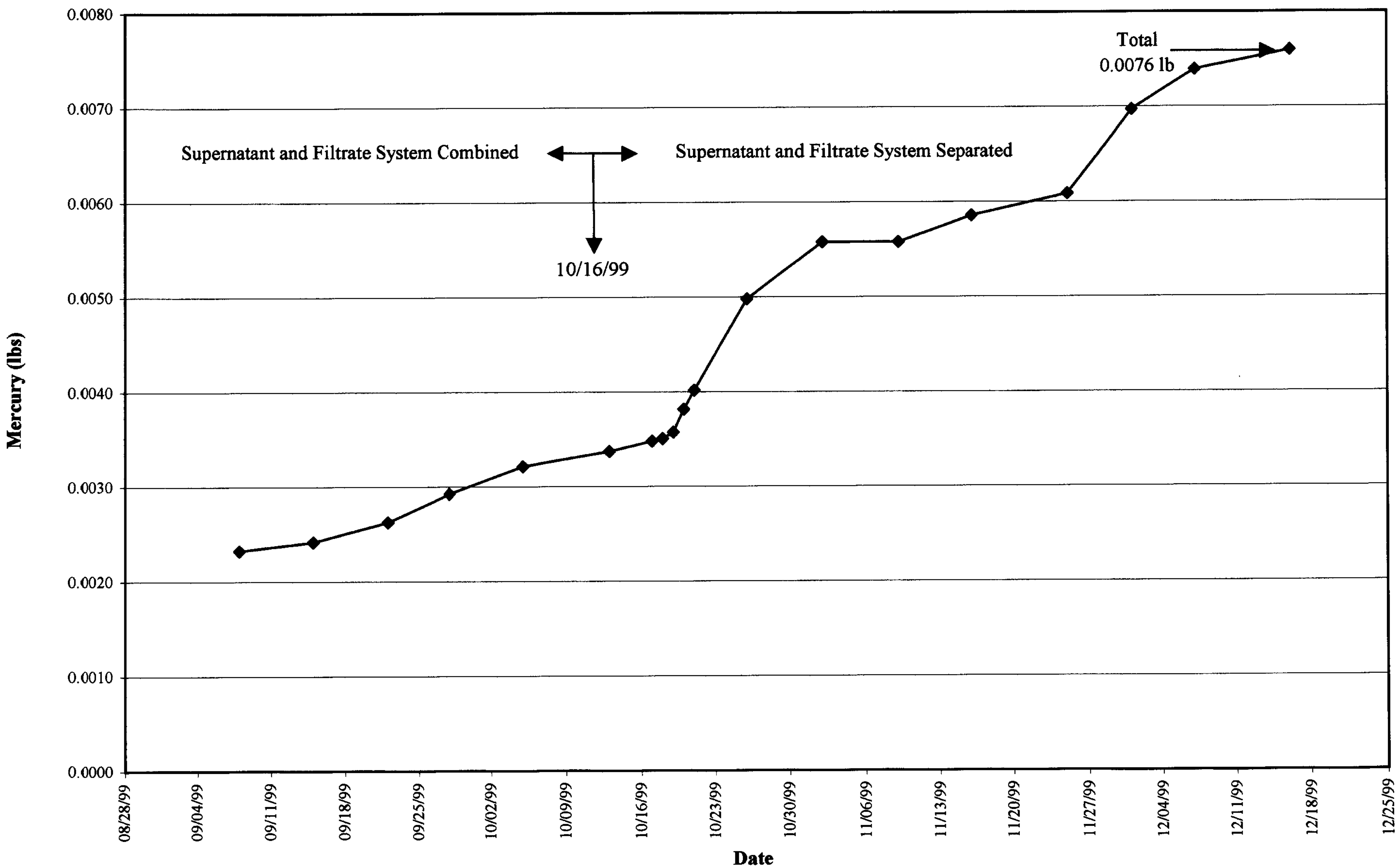


FIGURE 27 - EFFLUENT WATER (001)
MERCURY MASS DISCHARGED - CUMULATIVE

MONTGOMERY WATSON

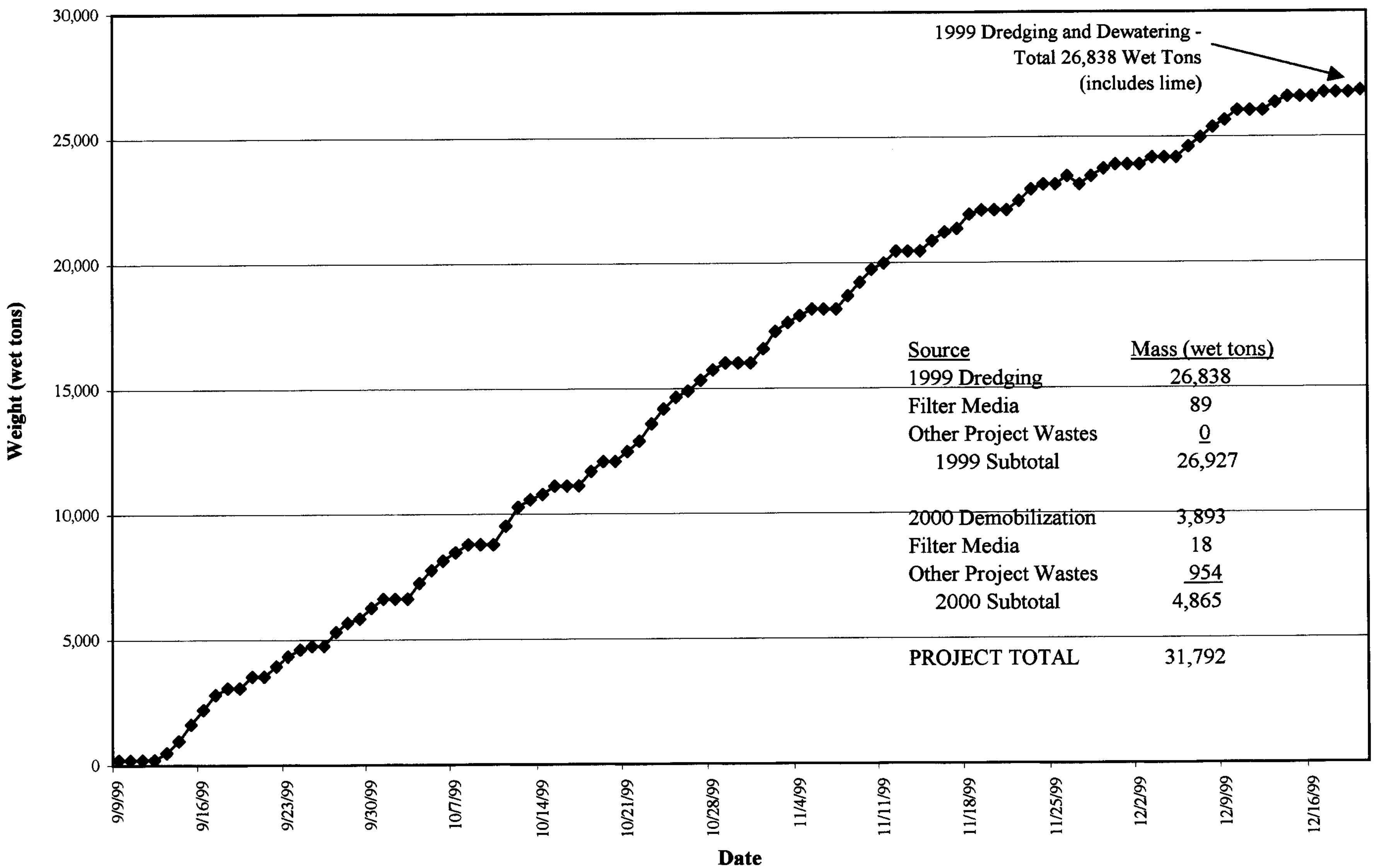
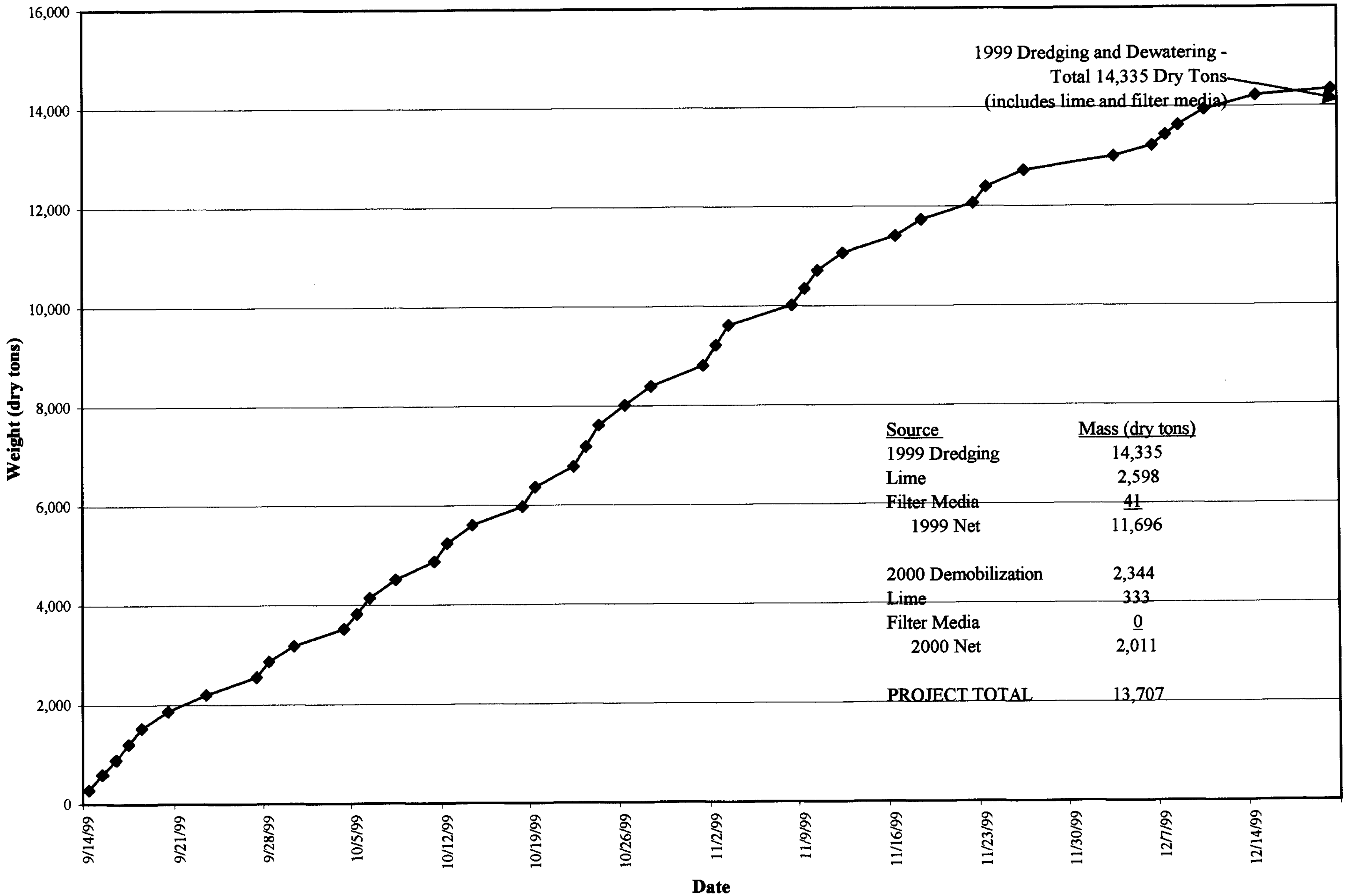


FIGURE 28 - DEWATERED SEDIMENT WET TONS LANDFILLED - CUMULATIVE



MONTGOMERY WATSON

FIGURE 29 - DEWATERED SEDIMENT DRY TONS LANDFILLED-CUMULATIVE

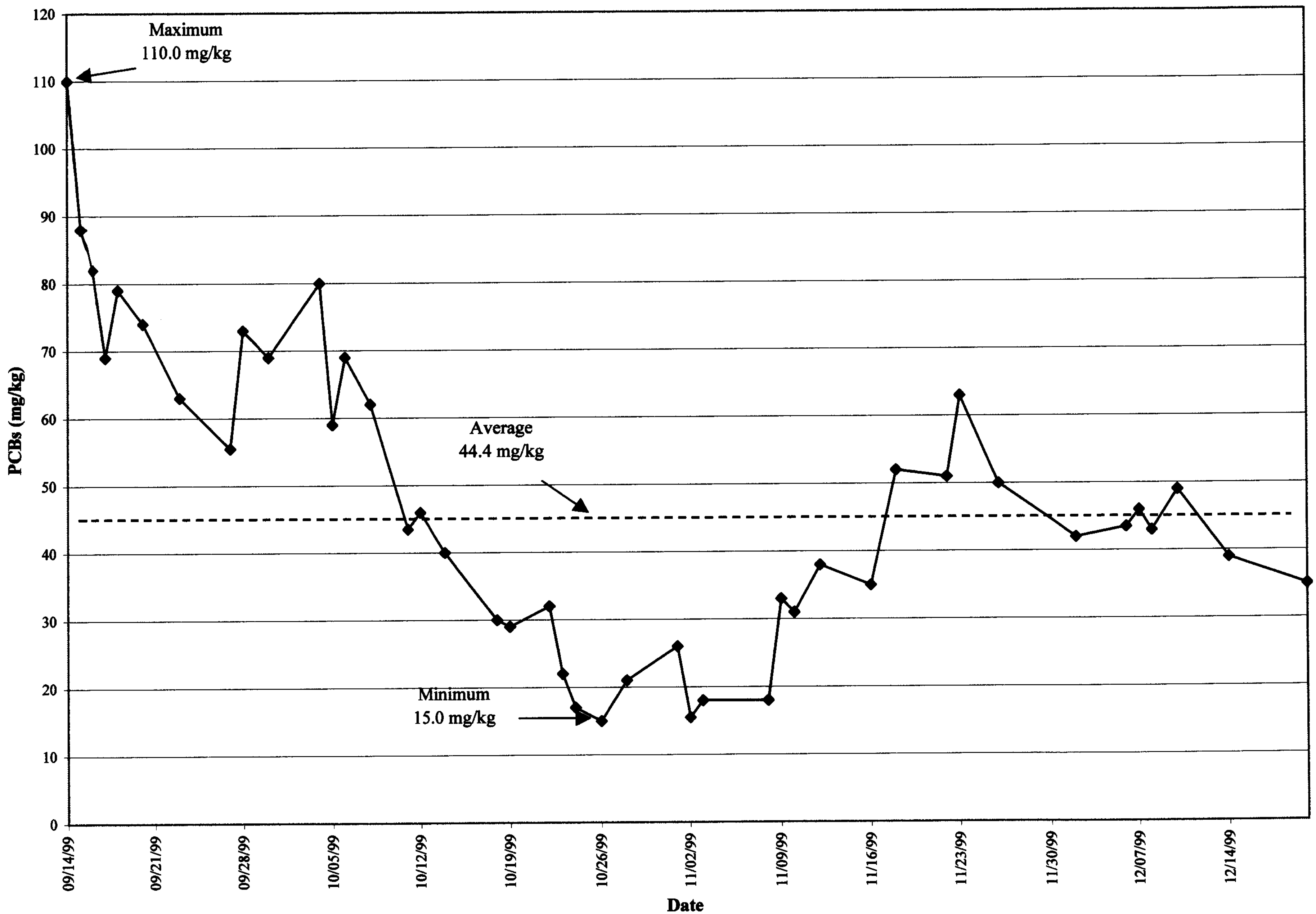


FIGURE 30 - DEWATERED SEDIMENT PCBs

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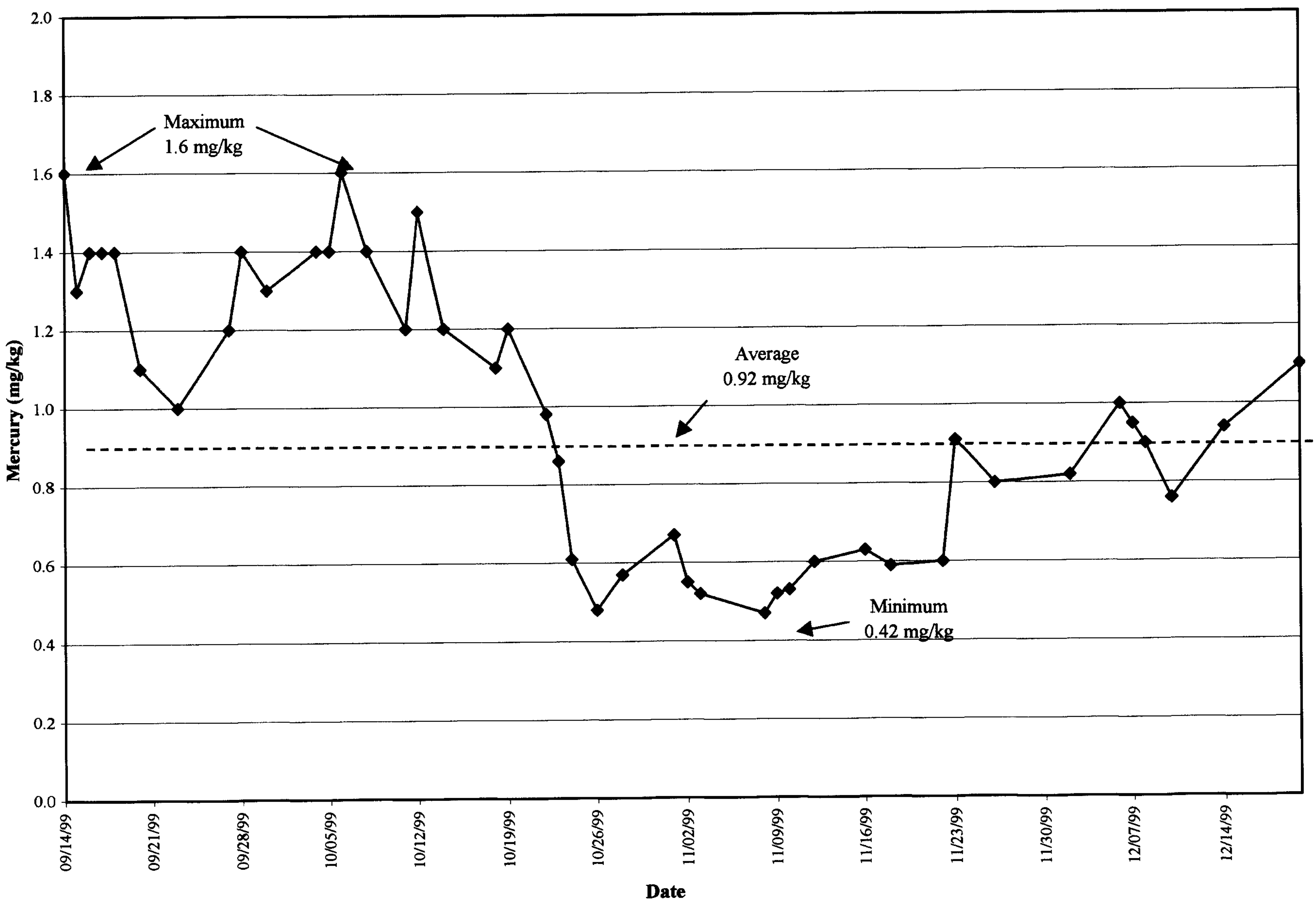

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FIGURE 31 - DEWATERED SEDIMENT MERCURY

AMS/jlv/RHW || N:/jobs/208/2057/01/wp/fig/Figure 32.xls

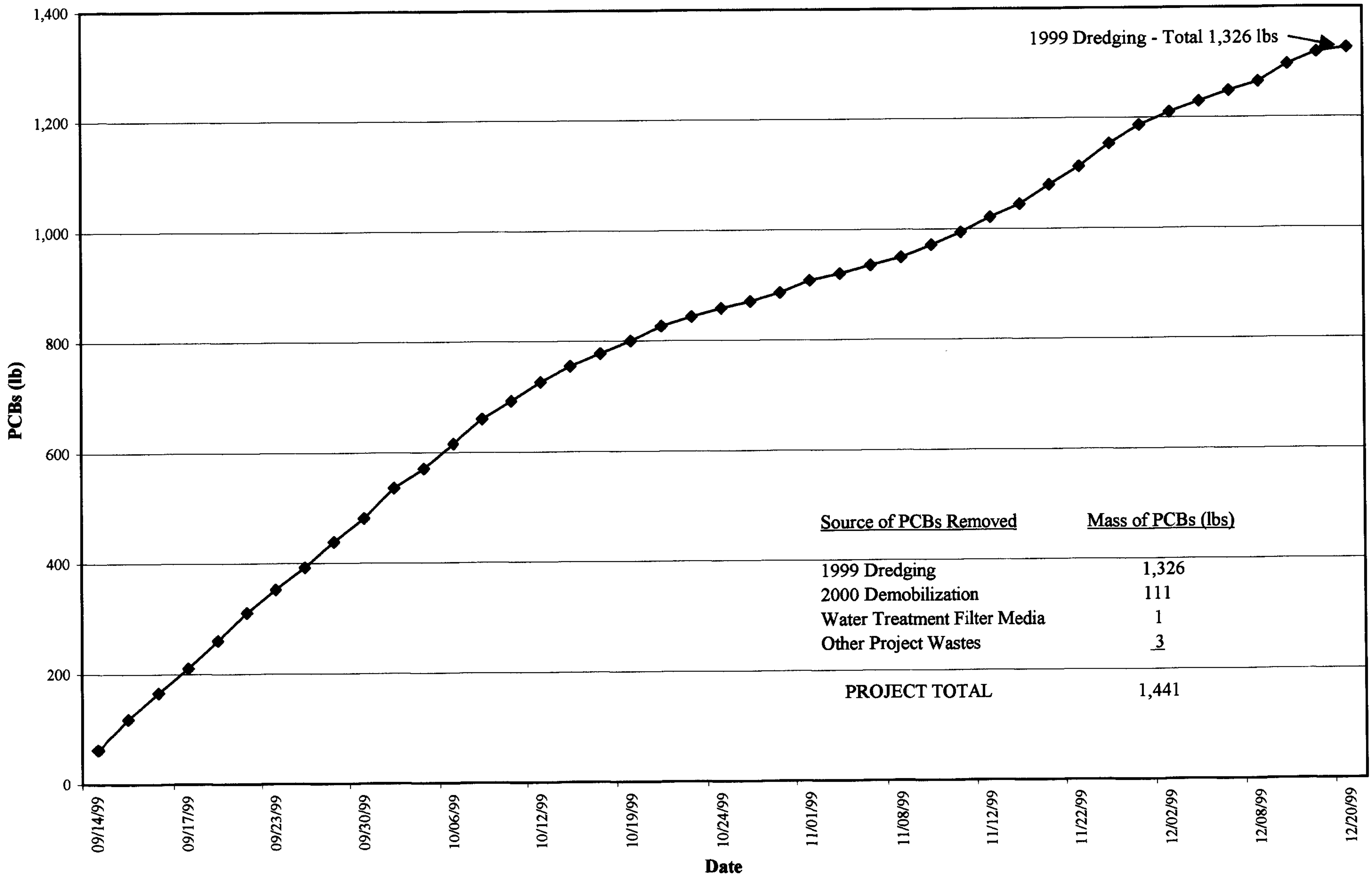

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FIGURE 32 - PCB MASS REMOVED BY DREDGING - CUMULATIVE

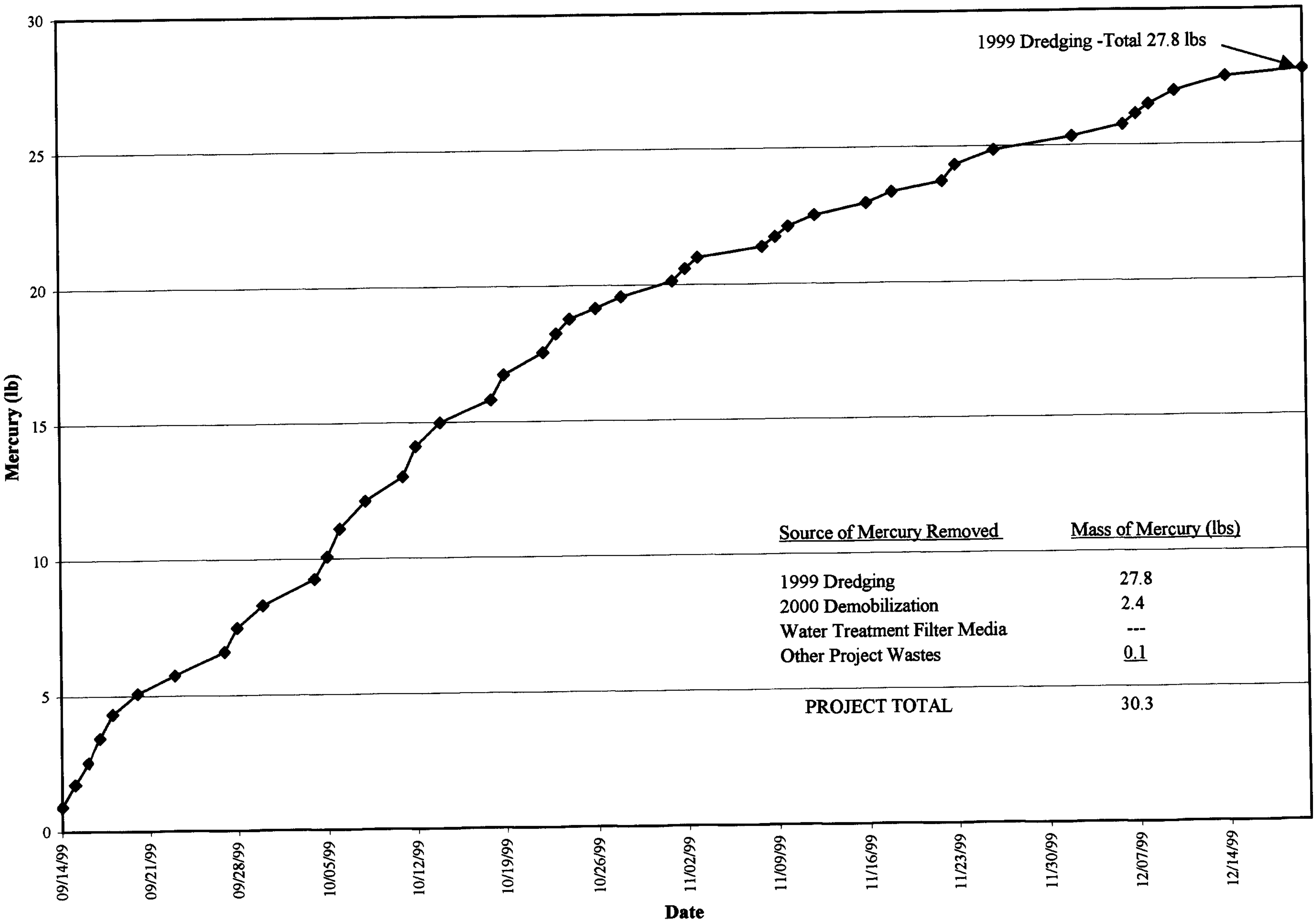

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FIGURE 33 - MERCURY MASS REMOVED BY DREDGING - CUMULATIVE

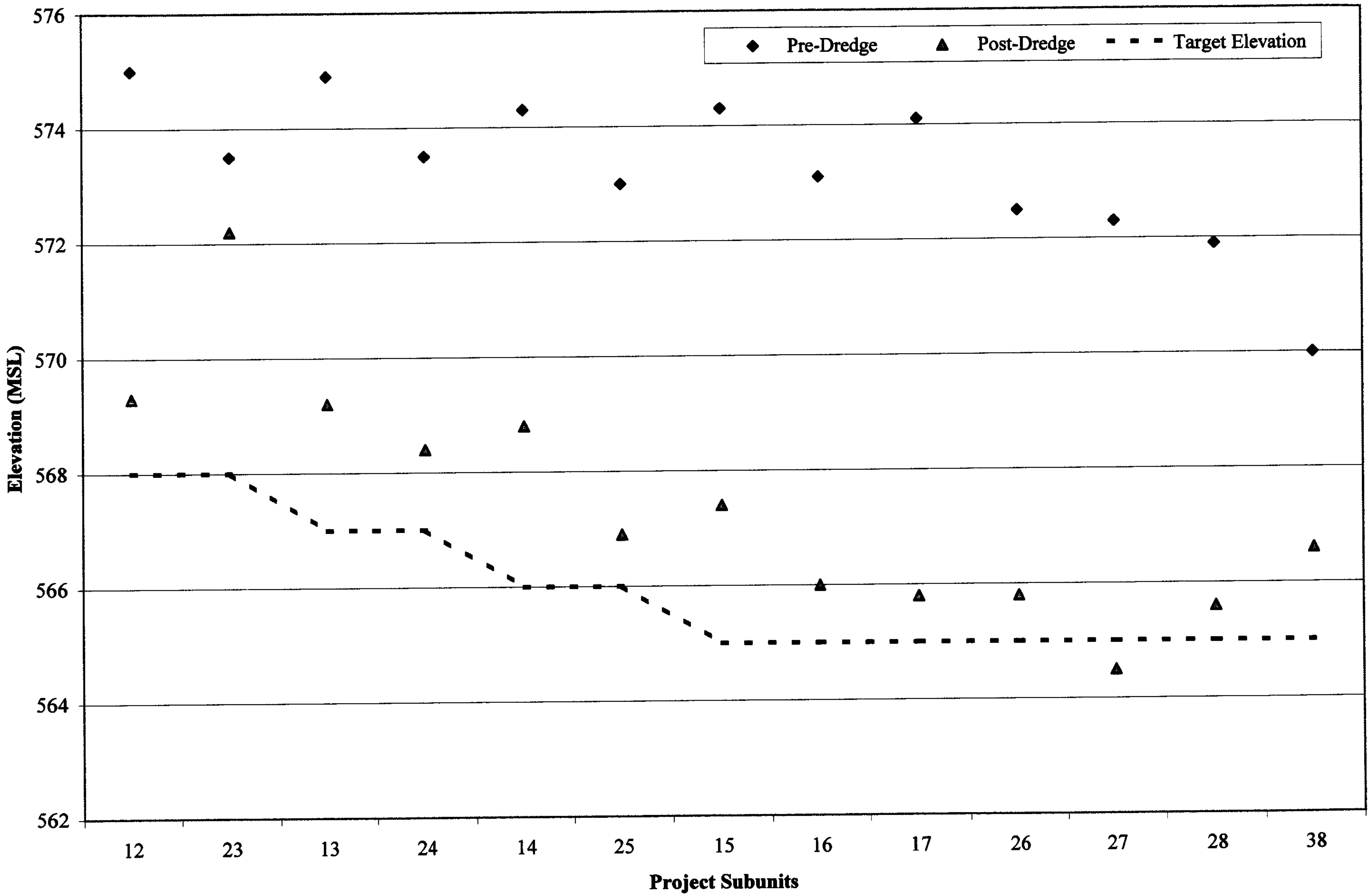

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FIGURE 34 - PRE- AND POST-DREDGE SEDIMENT ELEVATIONS

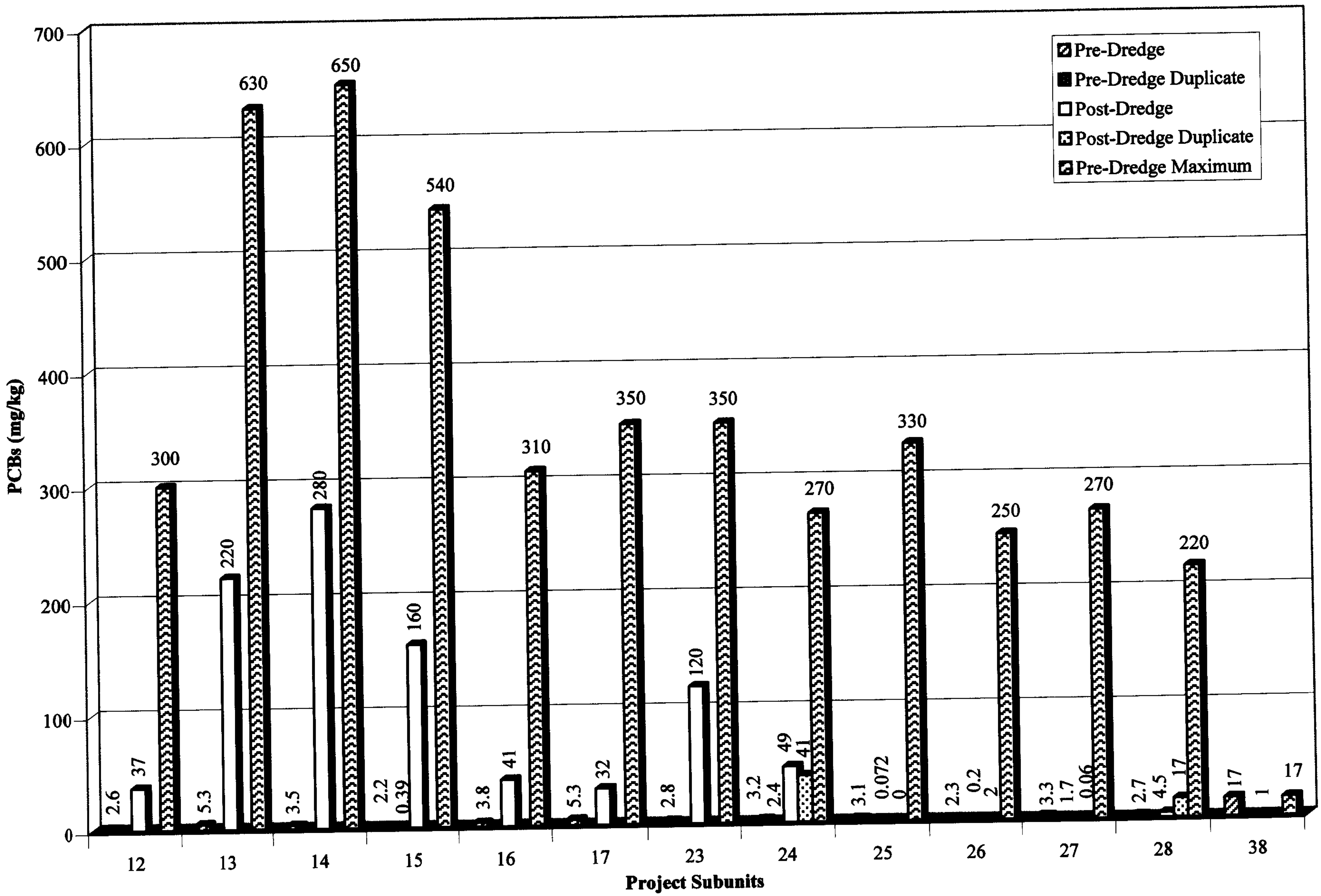

FIGURE 35 - PRE- AND POST-DREDGE SURFACE PCB CONCENTRATIONS

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ERD/erd/RHW || N:/jobs/208/2057/01/wp/fig/Figure 36.xls

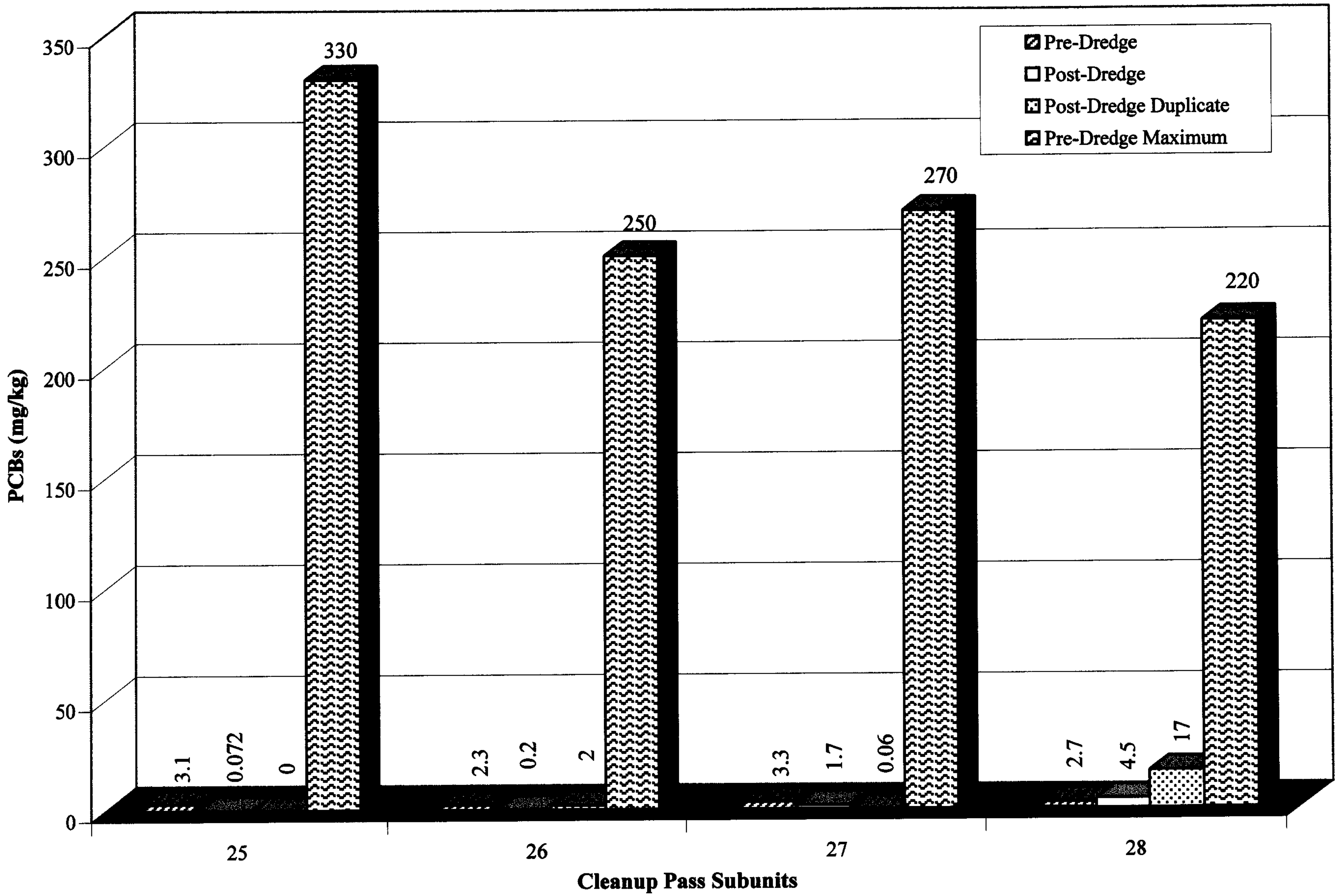

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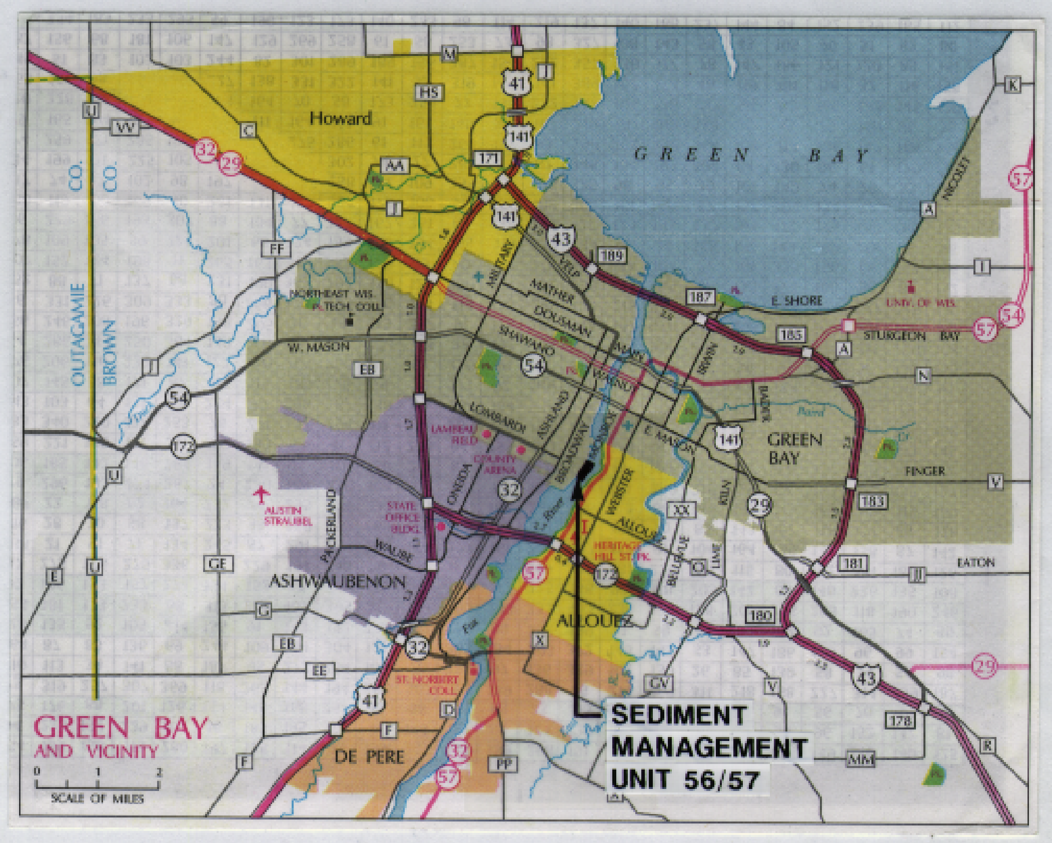
FIGURE 36 - PRE- AND POST-DREDGE SURFACE PCB CONCENTRATIONS AT CLEAN-UP PASS SUBUNITS

DRAWINGS



NOTES

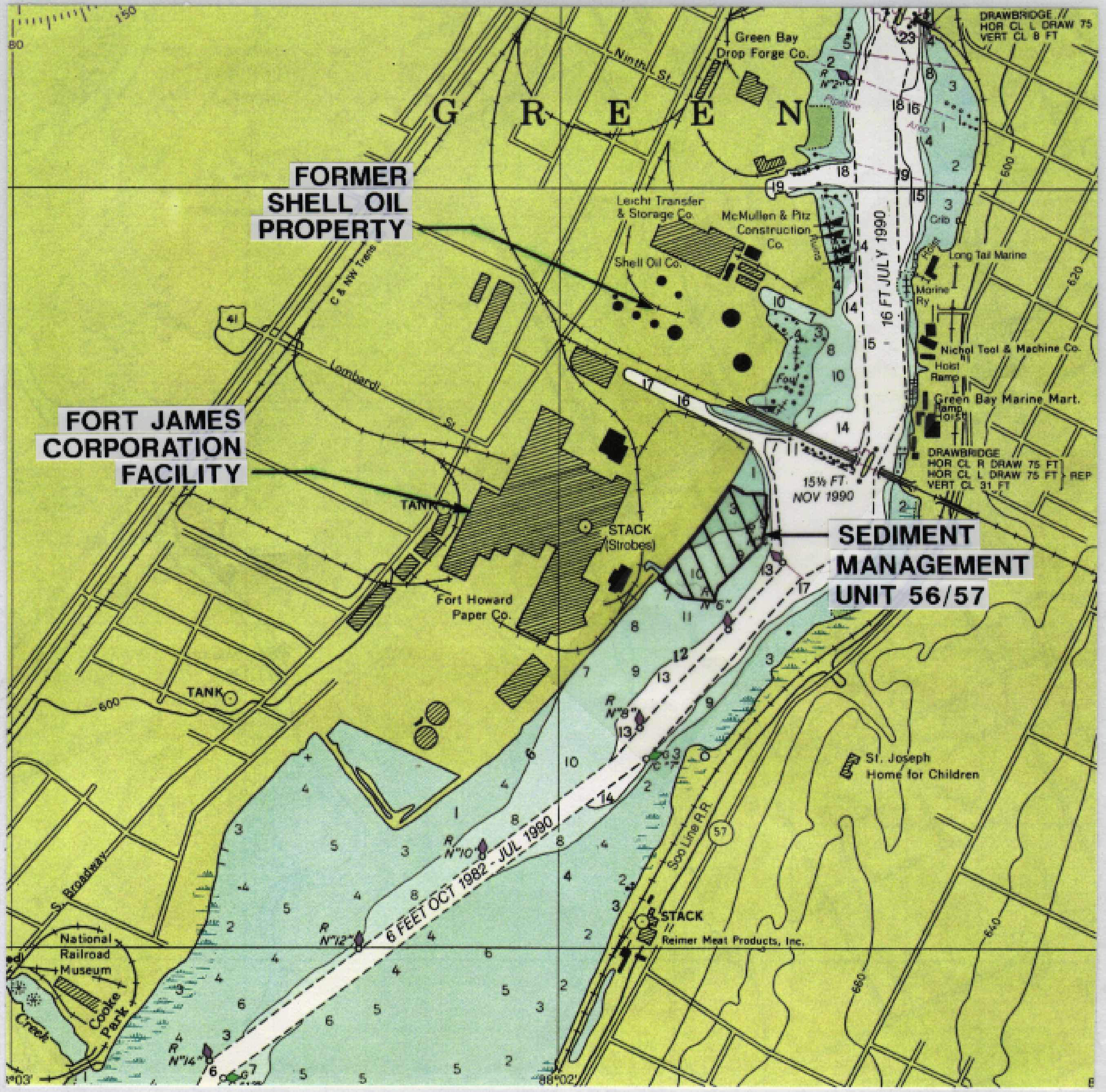
1. REFERENCE: 1997/1998 OFFICIAL STATE HIGHWAY MAP, WISCONSIN DEPARTMENT OF TRANSPORTATION.

north

Developed By RHW	Drawn By CCM	VICINITY MAP	Drawing Number 1272167 01250101 A1
Approved By	Date 5-15-98	BASIS OF DESIGN REPORT SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	MONTGOMERY WATSON
Reference			
Revisions			

QUALITY CONTROL
Graphic Standards CCM 5-5-98
Lead Professional
Technical Review
Project Manager
Management Review
Other

QUALITY CONTROL | Graphic Standards CCM | Lead Professional | 5-5-98 | Technical Review | Project Manager | Management Review | Other



This document has been developed for a specific application and may not be used without the written approval of Montgomery Watson.

NOTES

1. REFERENCE: RECREATIONAL CHART 14916, LAKE WINNEBAGO AND LOWER FOX RIVER, NOAA, 8th EDITION, OCTOBER 17, 1992.

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Developed By RHW	Drawn By CCM	LOCATION MAP	Drawing Number 1272167 01250101 A2
Approved By	Date 5-15-98	BASIS OF DESIGN REPORT SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	MONTGOMERY WATSON
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Revisions			

NOTE:

Date of photography: September 29, 1999.

north

0 250

Scale in Feet

Developed By RHW	Drawn By LCL	**SHELL PROPERTY AERIAL PHOTOGRAPH**	Drawing Number 1242291 01470101 **A3**
Approved By	Date 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	**MONTGOMERY WATSON**
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Revisions			

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Other
Technical Review
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Graphic Standards DLF 4-6-00
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LEGEND

DSO River monitoring location and number

NOTE

Date of photography: September 29, 1999.

north

0 250
Scale in Feet

Developed By RHW	Drawn By LCL	**DREDGE AREA AERIAL PHOTOGRAPH**	Drawing Number 1242291 01470101 A4
Approved By	Date 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	MONTGOMERY WATSON
Reference			
Revisions 1 Added river monitoring. dlf/9-19-01/rhw			

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Graphic Standards DLF 4-6-00
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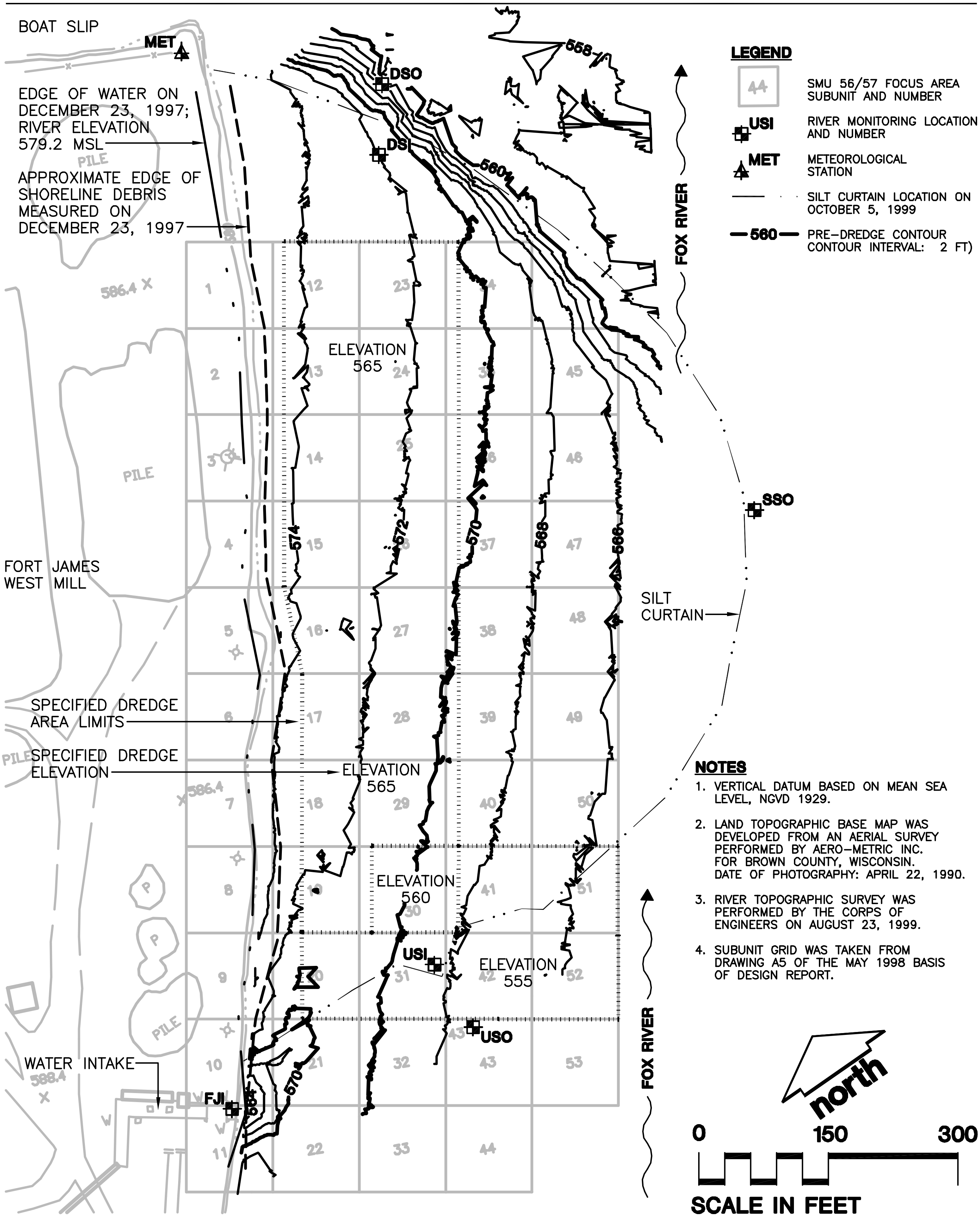

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL, NGVD 1929.
2. LAND TOPOGRAPHIC BASE MAP WAS DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY AERO-METRIC INC. FOR BROWN COUNTY, WISCONSIN. DATE OF PHOTOGRAPHY: APRIL 22, 1990.
3. RIVER TOPOGRAPHIC SURVEY WAS PERFORMED BY THE CORPS OF ENGINEERS ON AUGUST 23, 1999.
4. SUBUNIT GRID WAS TAKEN FROM DRAWING A5 OF THE MAY 1998 BASIS OF DESIGN REPORT.

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Graphic Standards DLF 4-6-00
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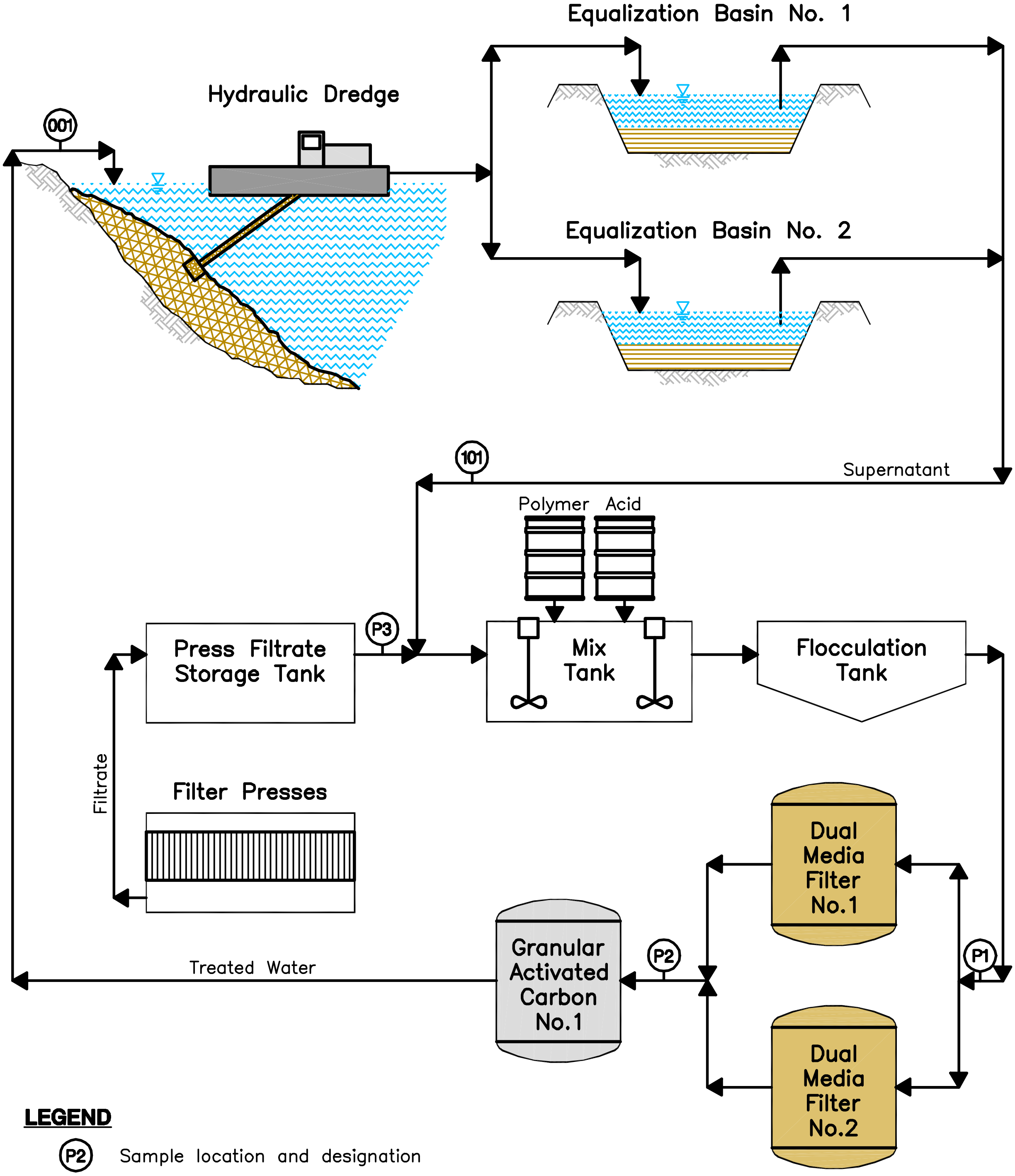
Developed By RHW	Drawn By DLF	**PRE-DREDGE MAP**	Drawing Number 1242291 01470101 **A5**
Approved By	Date 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	**MONTGOMERY WATSON**
Reference			
Revisions			



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Approved By		Date	4-6-00
Reference			
Revisions			

PROCESS FLOW DIAGRAM
ORIGINAL WATER TREATMENT SYSTEM

SEDIMENT REMOVAL DEMONSTRATION PROJECT
SEDIMENT MANAGEMENT UNIT 56/57
FOX RIVER, GREEN BAY, WISCONSIN

Drawing Number
1242291
01470101 A6

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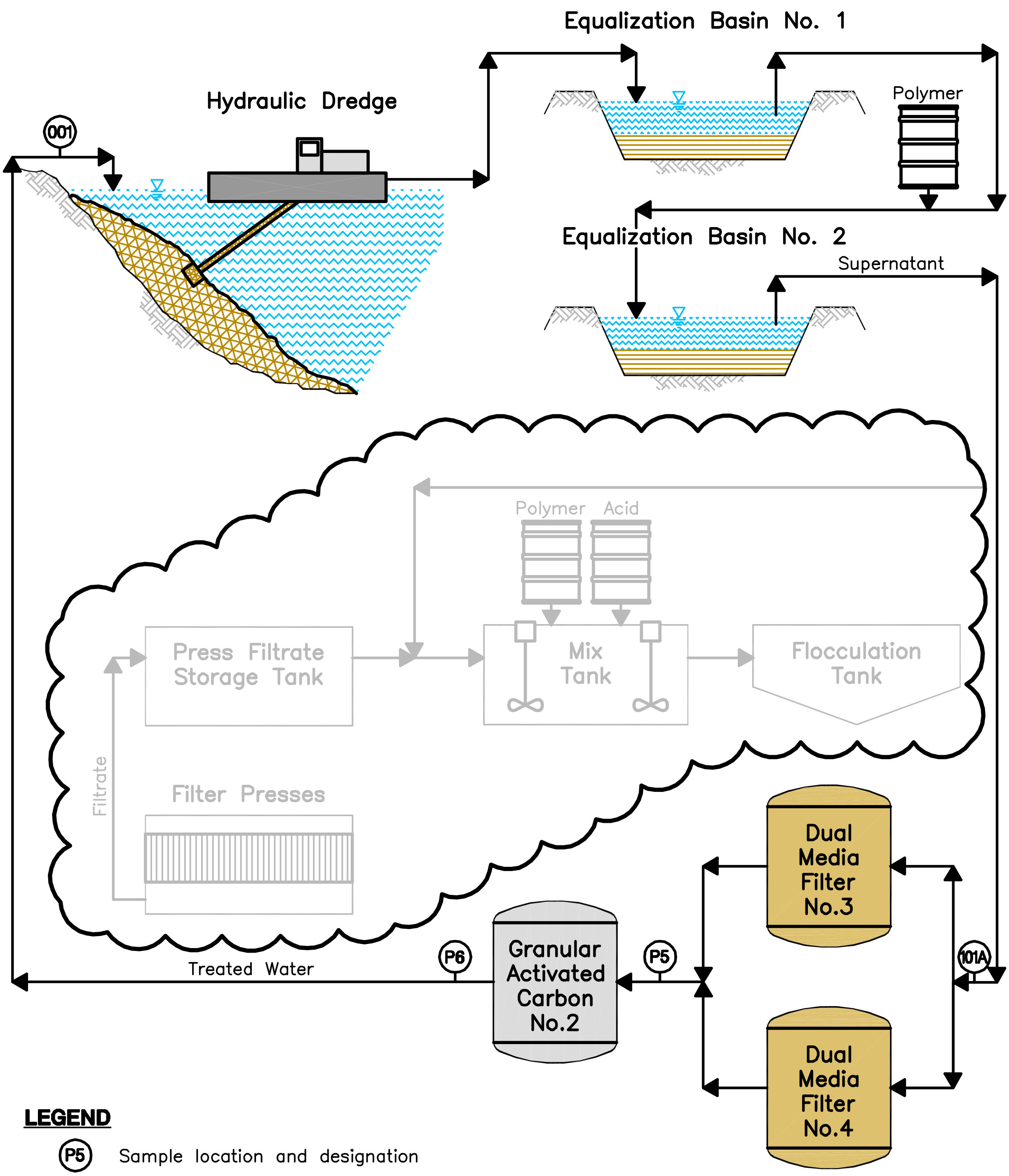
Project Manager RHW 4-6-00
Management Review
Other



LEGEND

(P5) Sample location and designation

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Approved By		Date	4-6-00
Reference			
Revisions			

PROCESS FLOW DIAGRAM
SUPERNATANT WATER TREATMENT SYSTEM

SEDIMENT REMOVAL DEMONSTRATION PROJECT
SEDIMENT MANAGEMENT UNIT 56/57
FOX RIVER, GREEN BAY, WISCONSIN

Drawing Number
1242291
01470101 A7

MONTGOMERY WATSON

QUALITY CONTROL
Graphic Standards DLF
Lead Professional
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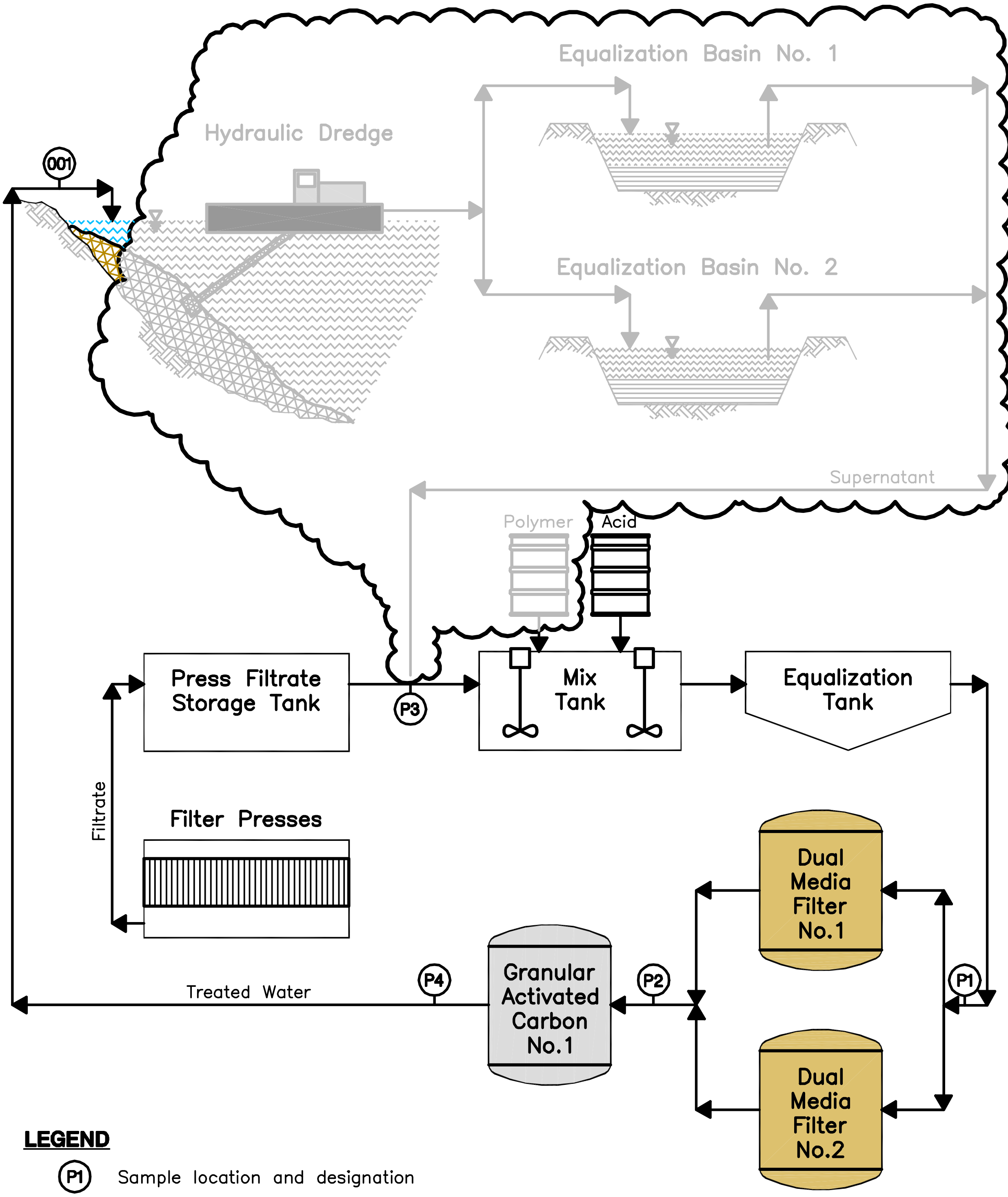
Technical Review
Project Manager RHW
4-6-00
Management Review
Other



LEGEND

(P1) Sample location and designation

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Technical Review
Project Manager RHW 4-6-00
Management Review
Other

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Revisions			

PROCESS FLOW DIAGRAM
FILTRATE WATER TREATMENT SYSTEM

SEDIMENT REMOVAL DEMONSTRATION PROJECT
SEDIMENT MANAGEMENT UNIT 56/57
FOX RIVER, GREEN BAY, WISCONSIN

Drawing Number
1242291
01470101 A8

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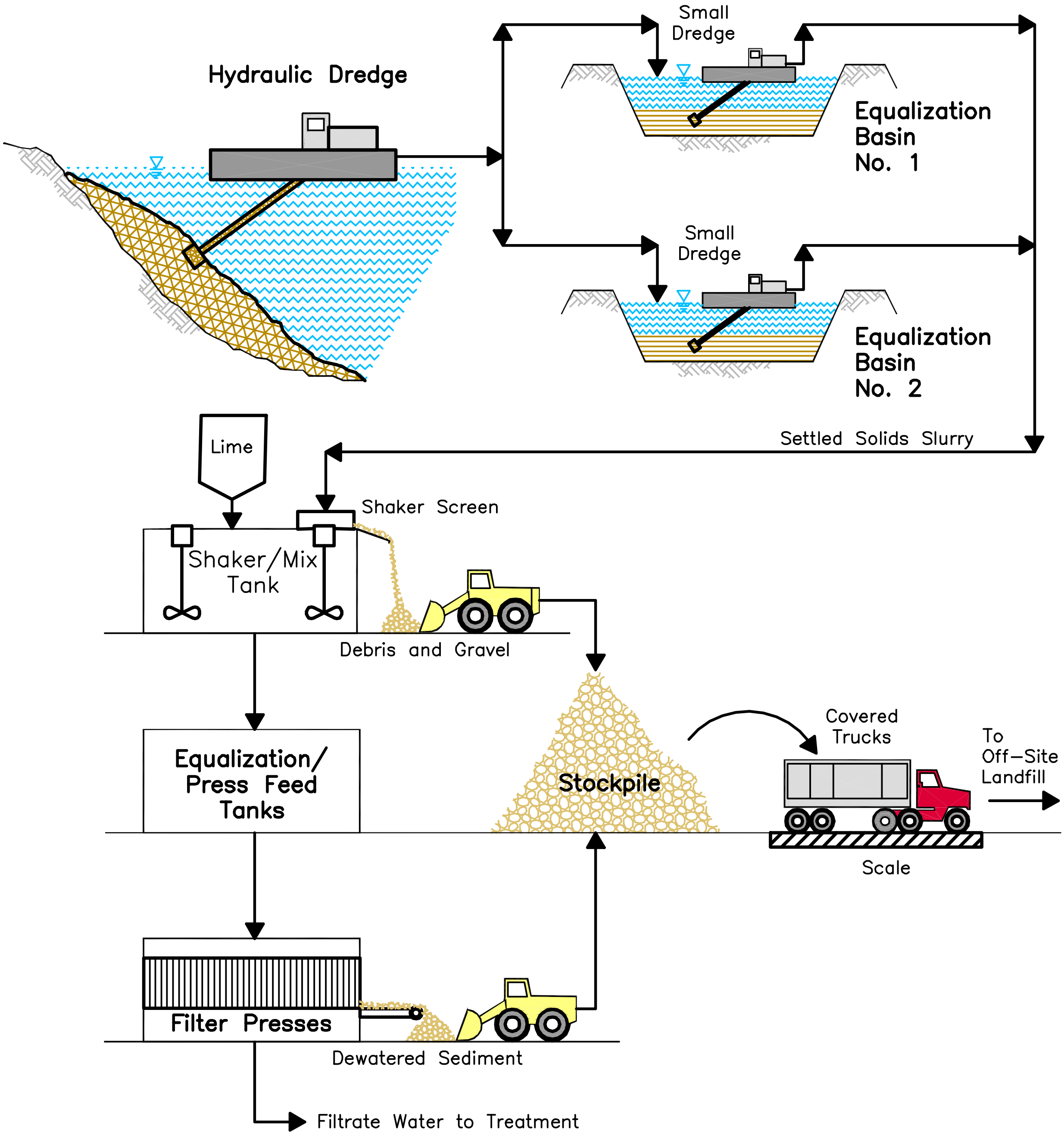

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Graphic Standards DLF 4–6–00
Lead Professional

Technical Review
Project Manager RHW 4–6–00

Management Review
Other

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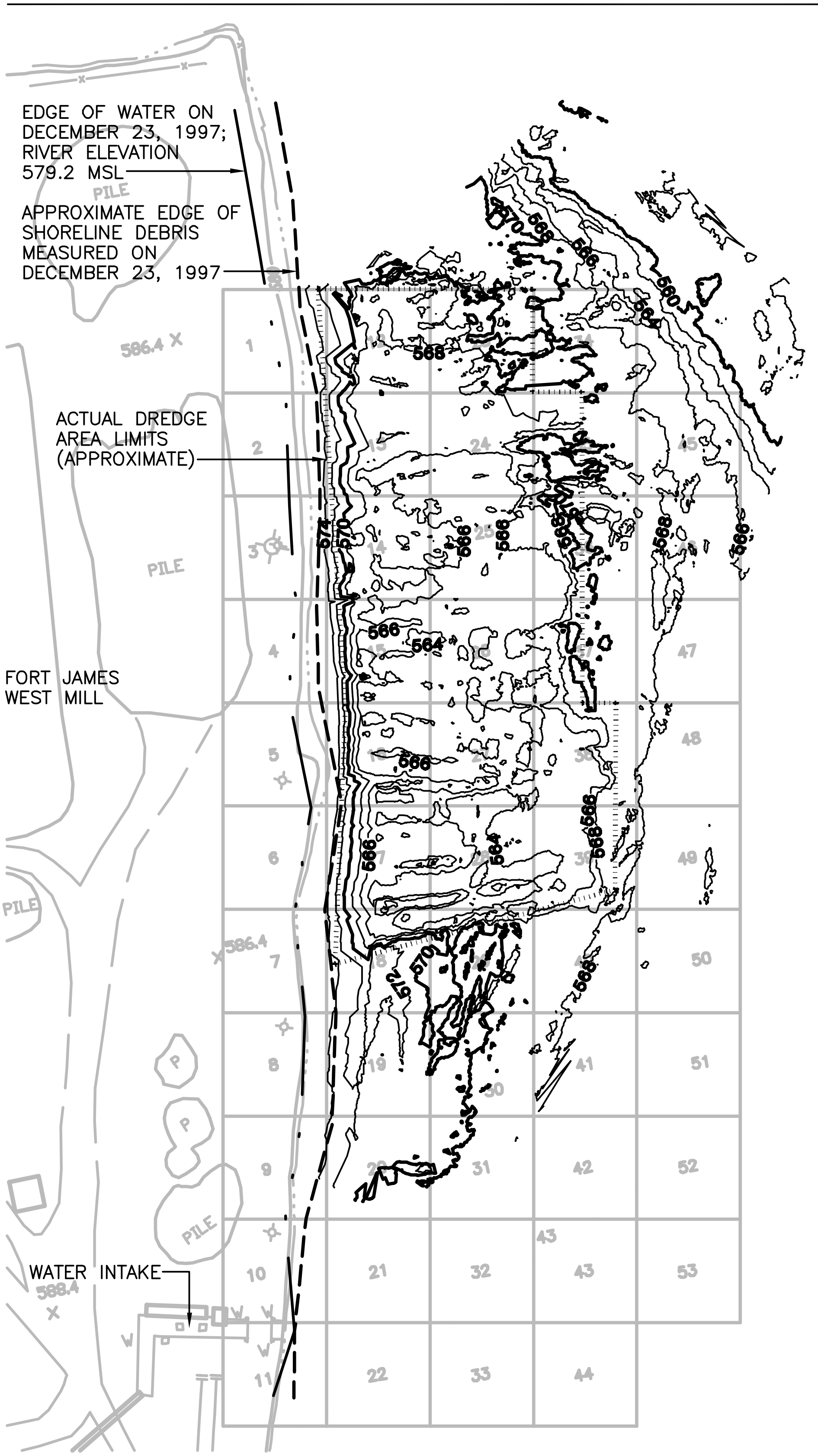
Revisions			

PROCESS FLOW DIAGRAM - DEWATERING

SEDIMENT REMOVAL DEMONSTRATION PROJECT
SEDIMENT MANAGEMENT UNIT 56/57
FOX RIVER, GREEN BAY, WISCONSIN

Drawing Number
1242291
01470101 A9

MONTGOMERY WATSON

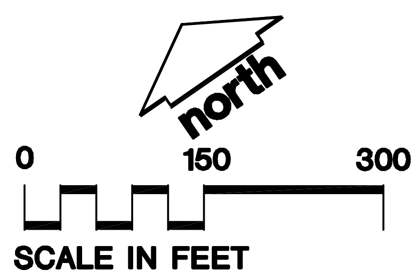


LEGEND

44	SMU 56/57 FOCUS AREA SUBUNIT AND NUMBER
— 570 —	POST–DREDGE CONTOUR (CONTOUR INTERVAL: 2 FT)

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL, NGVD 1929.
2. LAND TOPOGRAPHIC BASE MAP WAS DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY AERO–METRIC INC. FOR BROWN COUNTY, WISCONSIN. DATE OF PHOTOGRAPHY: APRIL 22, 1990.
3. RIVER TOPOGRAPHIC SURVEY WAS PERFORMED BY SUPERIOR SPECIAL SERVICES ON DECEMBER 20, 1999.
4. SUBUNIT GRID WAS TAKEN FROM DRAWING A5 OF THE MAY 1998 BASIS OF DESIGN REPORT.



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Technical Review
Project Manager RHW 4–6–00
Graphic Standards DLF 4–6–00
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Developed By RHW	Drawn By DLF	**POST-DREDGE MAP**
Approved By	Date 4–6–00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN
Reference		
Revisions		

Drawing Number 1242291 01470101 **A10**

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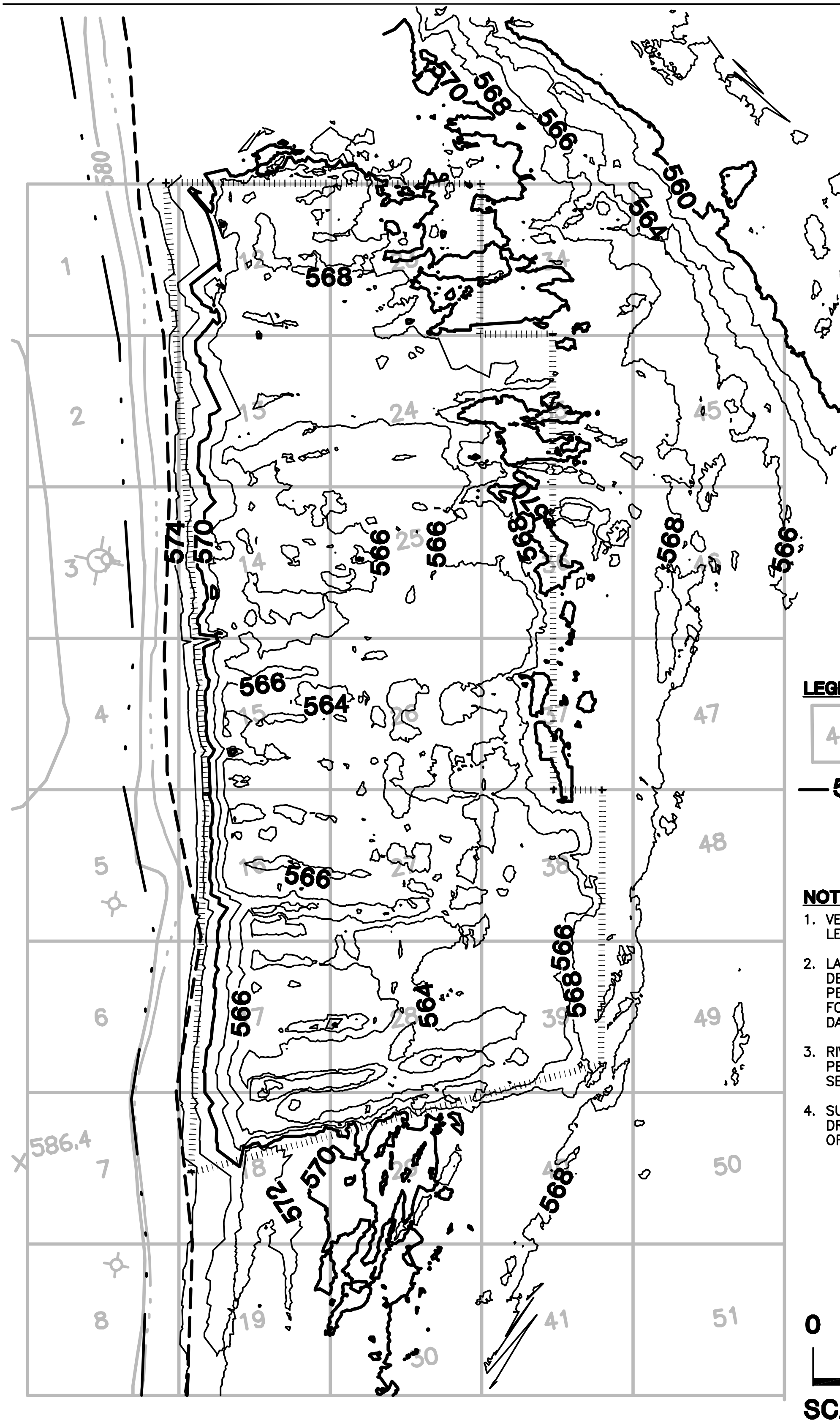


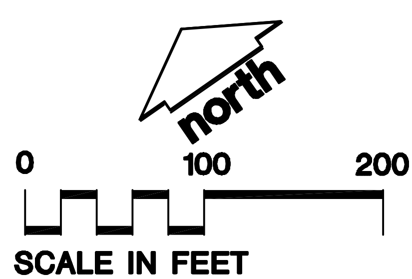
LEGEND

44 — SMU 56/57 FOCUS AREA SUBUNIT AND NUMBER

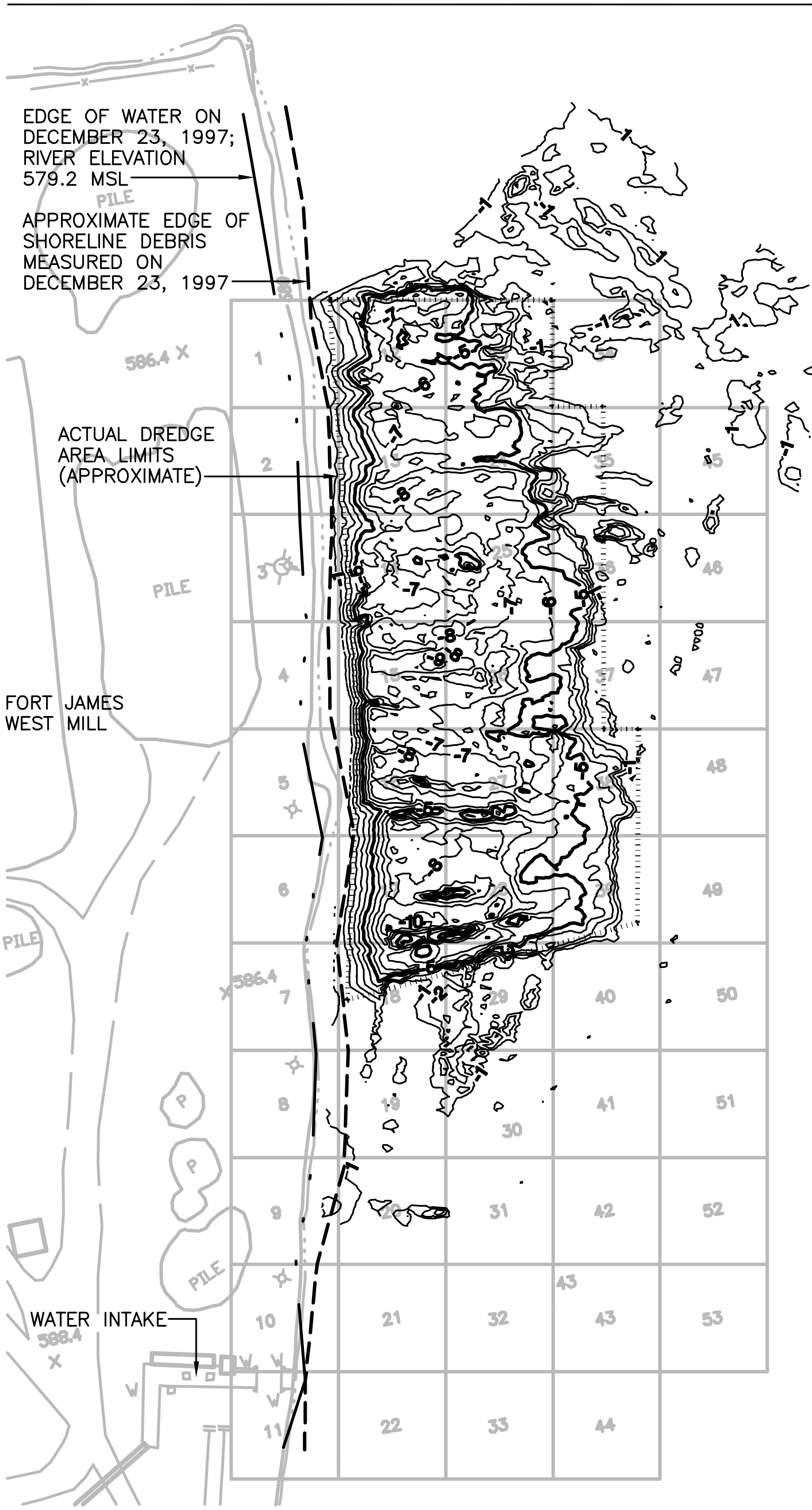
—507— POST-DREDGE CONTOUR (CONTOUR INTERVAL: 2 FT)

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL, NGVD 1929.
2. LAND TOPOGRAPHIC BASE MAP WAS DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY AERO-METRIC INC. FOR BROWN COUNTY, WISCONSIN. DATE OF PHOTOGRAPHY: APRIL 22, 1990.
3. RIVER TOPOGRAPHIC SURVEY WAS PERFORMED BY SUPERIOR SPECIAL SERVICES ON DECEMBER 20, 1999.
4. SUBUNIT GRID WAS TAKEN FROM DRAWING A5 OF THE MAY 1998 BASIS OF DESIGN REPORT.



Developed By RHW	Drawn By DLF	**POST-DREDGE MAP**	Drawing Number 1242291 01470101 **A10-a**
Approved By	Date 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	**MONTGOMERY WATSON**
Reference			
Revisions			



LEGEND

44 — SMU 56/57 FOCUS AREA SUBUNIT AND NUMBER

-5 — DREDGE THICKNESS ISOPACH CONTOUR (CONTOUR INTERVAL: 1 FT)

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL, NGVD 1929.
2. LAND TOPOGRAPHIC BASE MAP WAS DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY AERO-METRIC INC. FOR BROWN COUNTY, WISCONSIN. DATE OF PHOTOGRAPHY: APRIL 22, 1990.
3. DREDGE THICKNESS ISOPACH LINES WERE DEVELOPED BY COMPARING PRE-DREDGE AND POST-DREDGE ELEVATIONS.
4. SUBUNIT GRID WAS TAKEN FROM DRAWING A5 OF THE MAY 1998 BASIS OF DESIGN REPORT.

north

0 150 300

SCALE IN FEET

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Graphic Standards	DLF
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Project Manager	RHW
Date	4-6-00
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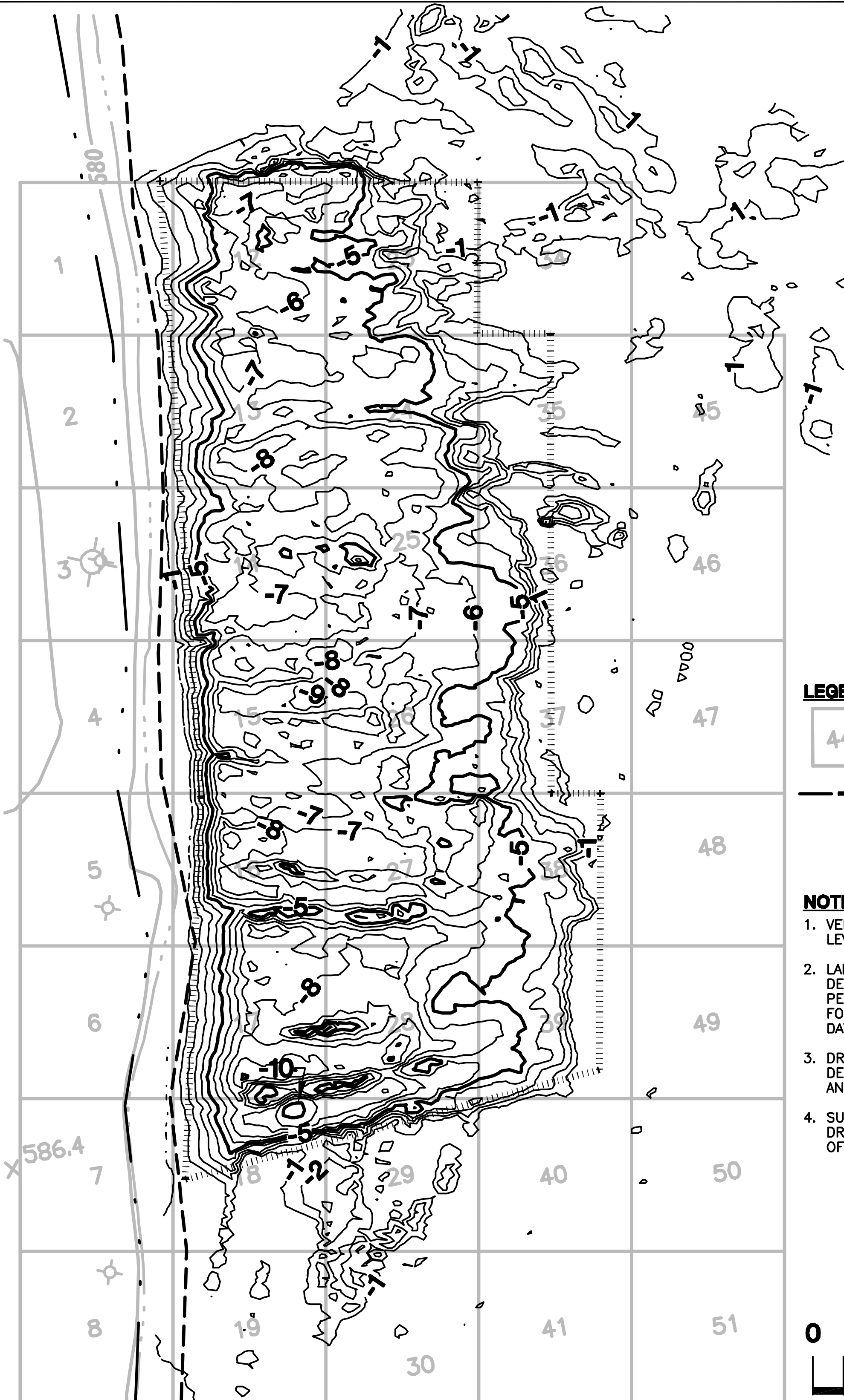
Other	

Developed By: RHW	Drawn By: DLF	**DREDGE THICKNESS ISOPACH MAP**	Drawing Number 1242291 01470101	**A11**
Approved By: [signature]	Date: 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	**MONTGOMERY WATSON**	
Reference				
Revisions				



LEGEND

44	SMU 56/57 FOCUS AREA SUBUNIT AND NUMBER
—— -5 ——	DREDGE THICKNESS ISOPACH CONTOUR (CONTOUR INTERVAL: 1 FT)

NOTES

1. VERTICAL DATUM BASED ON MEAN SEA LEVEL, NGVD 1929.
2. LAND TOPOGRAPHIC BASE MAP WAS DEVELOPED FROM AN AERIAL SURVEY PERFORMED BY AERO-METRIC INC. FOR BROWN COUNTY, WISCONSIN. DATE OF PHOTOGRAPHY: APRIL 22, 1990.
3. DREDGE THICKNESS ISOPACH LINES WERE DEVELOPED BY COMPARING PRE-DREDGE AND POST-DREDGE ELEVATIONS.
4. SUBUNIT GRID WAS TAKEN FROM DRAWING A5 OF THE MAY 1998 BASIS OF DESIGN REPORT.

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0 100 200

SCALE IN FEET

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Other
Technical Review
Project Manager RHW 4-6-00
Graphic Standards DLF 4-6-00
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Developed By RHW	Drawn By DLF	**DREDGE THICKNESS ISOPACH MAP**	Drawing Number 1242291 01470101 **A11-a**
Approved By	Date 4-6-00	SEDIMENT REMOVAL DEMONSTRATION PROJECT SEDIMENT MANAGEMENT UNIT 56/57 FOX RIVER, GREEN BAY, WISCONSIN	**MONTGOMERY WATSON**
Reference			
Revisions			

APPENDICES

APPENDIX A

PHOTOGRAPHS

Photo No. 1: Spare silt curtain panel. Note orange floatation, black silt curtain skirt, and slide connector.

Photo No. 2: Dredge slurry flow meter.

Photo No. 3: IMS 5012 Versi-Dredge in river.

Photo No. 4: Horizontal auger cutterhead on IMS 4010 Versi-Dredge.

Photo No. 5: On-shore booster pump.

Photo No. 6: Dredge slurry pipeline across boat slip.

Photo No. 7: Water treatment - chemical addition and flocculation/equalization.

Photo No. 8: Water treatment - filtration and granular activated carbon.

Photo No. 9: Small hydraulic dredge in west equalization basin. Note anchor and travel cables, and slurry discharge pipe.

Photo No. 10: Slurry shaker mix tank, lime storage tanks, and lime feed system.

Photo No. 11: Slurry equalization/press feed tanks.

Photo No. 12: Filter presses. Note water collection sump in asphalt work pad on lower left corner.

Photo No. 13: Filter cake being removed from press plates

Photo No. 14: Front-end loader removing dewatered sediment from press bins.

Photo No. 15: Loading dewatered sediment from stockpile into a truck.

Photo No. 16: Weighing a truck on a portable scale.

Photo No. 17: Truck tarped ready for trip to landfill.

Photo No. 18: Real-time turbidity monitor on a float at the sidestream position outside the silt curtain. Also note the anchor barge, silt curtain, dredge pipeline floatation, and dredge.

Photo No. 19: Real-time turbidity monitor on piling at the SSO position. Note the radio antenna, solar panel, data collection box, electric cabling, flasher light, and PVC pipe containing the turbidity sensor.

Photo No. 20: Automatic sampler on treated water discharge pipeline. Note flow meter on right side of sampler.

Photo No. 21: Dredge slurry sampling station at southeast corner of east equalization basin. Note valves on slurry pipe.

Photo No. 22: Measuring water depth before collecting a post-dredge sediment core sample. Note sample tube in boat and pipe in water marking the pre-dredge core location.

Photo No. 23: Performing post-dredge bathymetric survey inside silt curtain.

Photo No. 24 Removing piling from the river, which was used during dredge monitoring.

Photo No. 25: Disposal of sediment in Cell 12A at the modified Fort James industrial landfill in Green Bay.

Photo No. 26 Portable water treatment system used during clean out of the equalization basins and demobilization activities.

Photo No. 27: Discharge of treated demobilization wastewater to the Fort James West Mill.

Photo No. 28 Solidification of sediment in the west equalization basin using hydrated lime.

Photo No. 29: Loading of solidified sediment into trucks for offsite disposal.

Photo No. 30 Removing the HDPE liner from the equalization basins and scraping away the top few inches of the underlying compacted clay liner.

Photo No. 31: Pressure washing of the construction equipment on the asphalt work pad.

Photo No. 32 Removal of the manhole sump and backfill from the asphalt work pad. The manhole was salvaged but the backfill soils were disposed at the Fort James landfill.

APPENDIX B

DETAILED PROJECT COSTS

TABLE B-1
DETAILED PROJECT COSTS
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

	Item	Units	Quantity	Rate	Cost	Cost Per Cubic Yard Dredged (1)
I	**Investigation and Pre-Design**				$566,140	
II	**Procurement and Permitting**				$328,060	
	Pre-Construction Total				**$894,200**	
III	**Construction and Monitoring**					
A	Site Improvements & Restoration					
1	Clearing/Grubbing, Roads, Gravel Work Pads, Basins	Lump Sum	1	$322,630	$322,630	
2	Asphalt Work Pad and Seeding of Berm	Total	1	$34,920	$34,920	
3	Electric and Telephone Installation and Monthly Service	Total	1	$87,510	$87,510	
4	Site Winterization and Other Costs	Total	1	$26,670	$26,670	
5	Removal of PCB-Impacted Soils Adjacent to Asphalt Pad	Lump Sum	1	$25,000	$25,000	
	Site Improvements and Restoration Subtotal				$496,730	$16
B	Dredging (2)					
1	Mobilization/ Demobilization	Lump Sum	1	$277,790	$277,790	
2	Design, Install, Maintain, and Remove Silt Curtain	Lump Sum	1	$113,270	$113,270	
3	Operate Dredge, Maintain Pipeline, Perform Surveys (3)	Lump Sum	1	$38,190	$38,190	
4	Performance Bond	Lump Sum	1	$5,500	$5,500	
	Dredging Subtotal				$434,750	$14
C	Water Treatment (2)					
1	Final Design	Lump Sum	1	$21,070	$21,070	
2	Mobilization and Set-Up	Lump Sum	1	$74,730	$74,730	
3	Operate Treatment Plant (3)	Lump Sum	1	$38,195	$38,195	
4	Coagulant/Flocculent	Pound	340,030	$0.33	$112,210	
5	pH Adjustment Chemical	Pound	373,680	$1.54	$575,470	
6	Granular Activated Carbon Change-Out and Disposal	Pound	60,000	$2.33	$139,800	
7	Decontamination/ Demobilization	Lump Sum	1	$18,210	$18,210	
8	Performance Bond	Lump Sum	1	$5,500	$5,500	
	Water Treatment Subtotal				$985,185	$31

TABLE B-1
DETAILED PROJECT COSTS
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

D	Dewatering (2)					
1	Mobilization/ Demobilization	Lump Sum	1	$289,940	$289,940	
2	Dewater Sediments	Dry Ton	13,707	$45.22	$619,830	
3	Truck Scale Mobilization/ Demobilization	Lump Sum	1	$11,090	$11,090	
4	Truck Scale Rental	Day	105	$98	$10,290	
5	Performance Bond	Lump Sum	1	$5,500	$5,500	
	Dewatering Subtotal				$936,650	$30
E	Operational Monitoring and Construction Management					
1	Operational Monitoring	Total	1	$1,075,400	$1,075,400	$34
2	Construction Management	Total	1	$579,500	$579,500	$18
	Operational Monitoring and Construction Management Subtotal				$1,654,900	
	Subtotal A - E				$4,508,215	
F	Transportation and Disposal (4)					
1	Landfill Design, Construction, Operation, Closure, Post-Closure	Total	1	$1,796,435	$1,796,435	
2	Transportation	Total	1	$350,000	$350,000	
	Subtotal F				$2,146,435	$68
G	Project Insurance (5)	Lump Sum	1	$242,515	$242,515	$8
H	Environmental Monitoring (by others) (5)	Total	1	$1,180,100	$1,180,100	$38
	Subtotal G - H				$1,422,615	
	Construction and Monitoring Total				**$8,077,265**	$258
	Project Total				**$8,971,465**	

TABLE B-1
DETAILED PROJECT COSTS
FOX RIVER SMU 56/57 DEMONSTRATION PROJECT

I	Value of Fort James' In-Kind Services (4)					
1	Rental of Shell Property	Year	1.5	$368,550	$552,825	
2	Estimated Additional Costs if Out-of-State TSCA Landfill Disposal	Wet Ton	31,792	$85.67	$2,723,620	
3	Fort James Employees Time	Total	1	$66,755	$66,755	
4	Consultant Costs for Shoreline Stability Analyses	Total	1	$21,385	$21,385	
5	Consultant Costs for Shell Property Sampling and Analytical Testin	Total	1	$25,215	$25,215	
6	Construction Signs for Shell Property and Landfill	Total	1	$300	$300	
	Subtotal I				**$3,390,100**	$108
	Construction and Monitoring Total w/In-Kind Services				**$11,467,365**	$366
	Project Total w/In-Kind Services				**$12,361,565**	

Notes:

(1) Based on 31,346 cubic yards removed.

(2) Based on payments by the Fox River Group after settlement of a dispute with the primary subcontractor for dredging, water treatment, and dewatering.

(3) Operational costs for dredging and water treatment were back-calculated, as the balance remaining (split 50:50) after subtracting non-disputed payment items from the total payment to the subcontractor. The subcontractor's reported costs were higher.

(4) Based on reported project costs from Fort James Corporation.

(5) Based on reported project costs from the Fox River Group.